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Effect of Garden Grass Adsorbent on the Performance of Soil Aquifer Treatment (SAT)

Shivalinga Saboji S, Nagarajappa D. P, Manjunath N.T, Manjunatha K

Abstract*: *In the present work, Garden Grass was used to enhance the removal efficiency of Soil Aquifer System (SAT) for the removal of Cadmium(Cd) and Lead(Pb). The column studies were carried out using 3 different concentrations for both metals in Synthetic water (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 Cd and Pb without Garden Grass resulted in 47.2%, 49.8%, 45.5% for Cd and 38.4%, 44.5%, 43% for Pb. The conjunction of Garden Grass in SAT resulted in increased removal efficiency. Whereas the efficiency was observed maximum at 80% height of adsorbent resulting in 81.6%, 82.4%, 69.7% for Cd and 36.7%, 57.2%, 48.2% for Pb. Comparison studies show that SAT in conjunction with Garden Grass showed better performance than without adsorbent one.

Index Terms: Cadmium, Garden Grass SAT, Synthetic water.

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].

Soil Aquifer Treatment (SAT) is artificial recharge of groundwater through infiltration basins, a high degree of upgrading can be achieved by allowing partially-treated sewage effluent to infiltrate into the soil and move down to the groundwater. The unsaturated or vadose zone acts as a natural filter and can remove essentially all suspended solids, biodegradable materials, bacteria, viruses and other microorganisms. Significant reductions in nitrogen, phosphorus and heavy metal concentrations can also be achieved [2].

Cadmium is one of the dangerous heavy metals with a biggest potential hazard to people and the earth. It is a non-essential and non-helpful component to plants and animals. In high concentrations, cadmium may influence human wellbeing. Diseases for example, renal harm, anemia, hypertension and itai–itai are connected with presence of cadmium. It causes kidney harm, bone sicknesses and tumor. Chronic exposure to elevated levels of cadmium is known to cause renal brokenness, bone degeneration, liver harm [3].

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 ascauses effects to the immune system.[4].

A low cost adsorbent is one which needs a little processing before use, abundant in nature, a by-product or waste material from another industry. Of course improved sorption capacity may compensate the cost of additional processing. Therefore it becomes very very important to investigate all possible agro and horticultural based inexpensive adsorbents to be explored and their feasibility for the removal of heavy metals to be studied in all respects [5].

This study infuses SAT with Garden Grass to remove heavy metals 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, Pradeep Semil [4] 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. Pandhare, Nikhilesh Trivedi, Rajesh Pathrabe, S. D. Dawande [6] 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.

Nagarajappa D.P, Manjunatha K and Manjunath N.T [7]

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Shivalinga Saboji S, Department of Civil Engineering, UBDT College of Engineering, Davangere, India.

Dr. Nagarajappa D.P, Professor and PG CO-coordinator, Department of Civil Engineering, UBDT College of Engineering, Davangere, Karnataka, India.

Dr. Manjunath N.T, Professor, Department of Civil Engineering, UBDT College of Engineering, Davangere, Karnataka, India.

Dr. Manjunatha K, Professor and Chairman, Department of Civil Engineering, UBDT College of Engineering, Davangere, Karnataka, India.

carried out Bench scale column studies to analyse the potential of SAT system in treating three wastewaters i.e low, medium and high strength wastewaters under varied experimental condition viz. soil type, depth of soil mass, initial concentration of pollutants and pH. Based on the analysis of results the conclusions have been drawn. Sat system with silty sand was more efficient in treating wastewater compared to clayey sand.

Evbuomwan B. O, Atuka M.M, [3] studied the biosorption of Cd(II) from aqueous solution onto garden grass(GAG) using batch adsorption technique. The results showed that garden grass has considerable potential that can be used as an effective adsorbent for the removal of cadmium ions from aqueous solutions.

III. METHODOLOGY

A. Adsorbent Preparation

The Garden Grass was collected inside the UBDTCE campus and it was washed thoroughly with clean water for several times to remove the earthy matter and all the dirt particles and then rinse with de-ionized water. They were cut into smaller bits and sun-dried for 72 hours. After drying, the dried Garden Grass was grounded and sieved to get the average adsorbent size of 1.7mm.

B. Preparation of Metal Solution (Synthetic water)

Analytical rated reagents were utilized for preparing metal solutions. Cd^{2+} and Pb^{2+} solutions were arranged by diluting merck grade stash solutions with deionised water to a desired concentration. Concentrated H_2SO_4 and NaOH were applied to adjust neutral pH values of samples. The solutions were diluted to different known concentrations viz. 5, 15 and 25mg/L for testing performance of SAT system. They were 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 upto 0.8m depth. When conducting experiment with adsorbent, 4 adsorbent heights were tried at 20%, 40%, 60% and 80% of 0.8m soil depth. Synthetic water 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 Garden Grass adsorbent

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

S l No.	Paramete r	Influent Conc. (mg/L)	Effluent Conc. (mg/L)	Removal Efficiency, %
1	Cadmium	5	2.64	47.2
2		15	7.52	49.8
3		25	13.62	45.5
4	Lead	5	3.08	38.4
5		15	8.32	44.5
6		25	14.24	43

Table.1 shows the performance of SAT system without adsorbents. The Loamy Sand soil used showed better for removing Cadmium than Lead. It was recorded that Loamy Sand removed maximum Cadmium from 15mg/L influent concentration which is 49.8% . The values were recorded at optimum values which were calculated by saturation studies. The least removal was 45.5% which is not much significant. Hence average values can be taken for consideration for different influent concentration. Overall average performance of SAT for Cadmium removal is 47.5% and for Lead is 42% in without adsorbent case.

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

The column studies was carried out with different Cadmium and Lead influent concentrations from 5 mg/L to 25 mg/L with a difference of 10mg/L. Statistically, Loamy sand showed higher performance for Cadmium than Lead but when it was coupled with Garden Grass it showed better performance for Cadmium and the efficiency was much more enhanced in the latter case. The performances of SAT with Garden Grass at different heights of the column are summarized in figures below.

Fig.1 shows optimum removal of Cadmium and Lead at 20% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Cadmium removal efficiency were found to be 76.4%, 78.1% and 74.6% respectively for influent concentrations mentioned.

Similarly Lead removal efficiencies were obtained as 49.4%, 56.6% and 53.8% respectively. Maximum removal efficiency at 20% height of adsorbent for Cadmium is 78.1% for influent concentration of 15 mg/L which is comparatively much lower for Lead found as 56.6% for15mg/L.

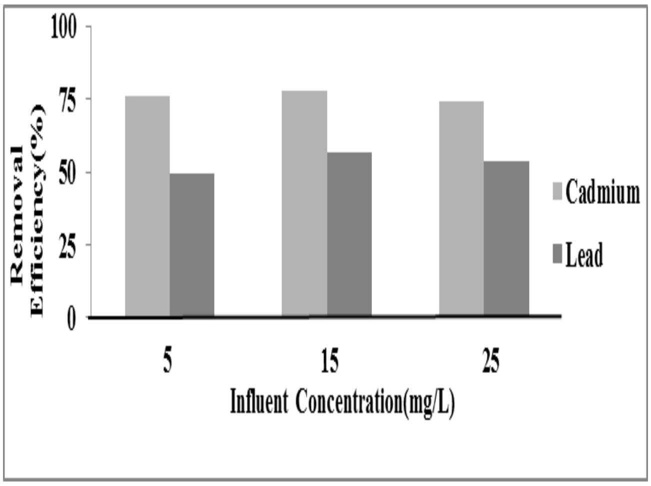

Fig.1. Removal Efficiencies for Cd and Pb for Loamy Sand Soil with Garden Grass adsorbent at 20% height.

Fig.2 shows optimum removal of Cadmium and Lead at 40% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Cadmium removal efficiency were found to be 77.6%, 78.7% and 73.6% respectively for influent concentrations mentioned. Similarly Lead removal efficiencies were obtained as 48.6%, 55.8% and 53.5% respectively. Maximum removal efficiency at 40% height of adsorbent for Cadmium is 78.7% for influent concentration of 15 mg/L which is comparatively much lower for Lead found as 55.8 % for 15 mg/L.

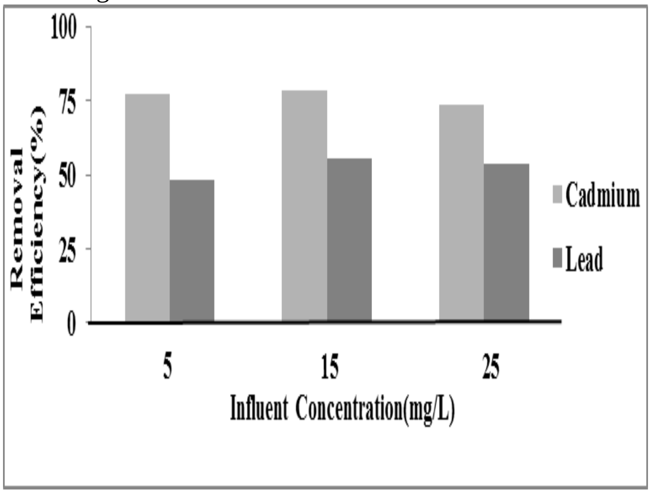

Fig.2. Removal Efficiencies for Cd and Pb for Loamy Sand Soil with Garden Grass adsorbent at 40% height.

Fig.3 shows optimum removal of Cadmium and Lead at 60% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Cadmium removal efficiency were found to be 79.4%, 78.3% and 71.1% respectively for influent concentrations mentioned. Similarly Lead removal efficiencies were obtained as 47%, 54.5% and 53% respectively. Maximum removal efficiency at 60% height of adsorbent for Cadmium is 79.4% for influent concentration of 10 mg/L which is comparatively much lower for Lead found as 54.5% for 15 mg/L.

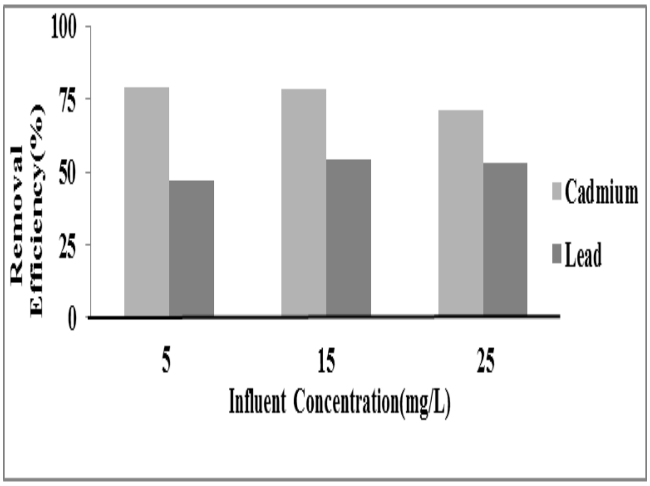

Fig.3. Removal Efficiencies for Cd and Pb for Loamy Sand Soil with Garden Grass adsorbent at 60% height.

Fig.4 shows optimum removal of Cadmium and Lead at 80% adsorbent height for influent concentrations of 5, 15, and 25 mg/L. Cadmium removal efficiency were found to be 81.6%, 82.4% and 69.7% respectively for influent concentrations mentioned. Similarly Lead removal efficiencies were obtained as 36.7%, 57.2% and 48.2% respectively. Maximum removal efficiency at 80% height of adsorbent for Cadmium is 82.4% for influent concentration of 15 mg/L which is comparatively much lower for Lead found as 57.2% for 15 mg/L.

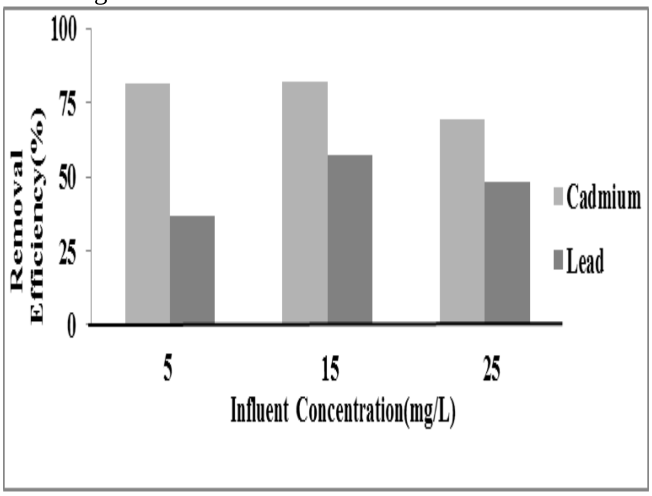

Fig.4. Removal Efficiencies for Cd and Pb for Loamy Sand Soil with Garden Grass adsorbent at 80% height.

The study of results indicates that there is no significant change in removal efficiency for both metals 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 Garden Grass. Fig.5. shows the comparison of performance of SAT for Cd and Pb removal without adsorbent and adsorbent at 80% height. From the statistics, Cadmium is removed effectively by Loamy Sand soil than Lead which in turn is significantly increased by combining it with Garden Grass.

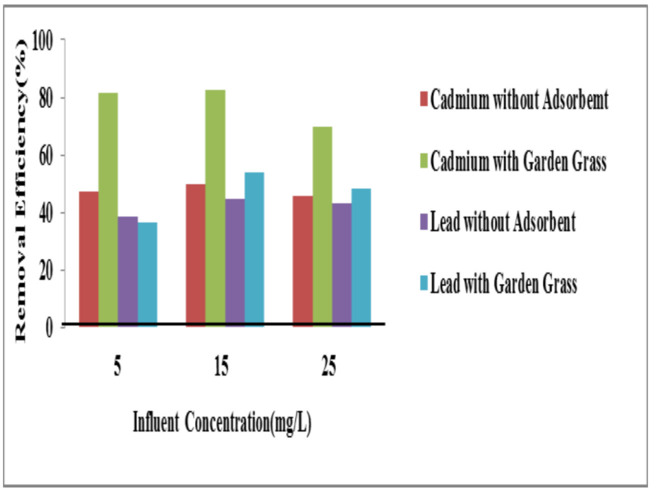

Fig.5. Comparison of removal of Cadmium and Lead by SAT without and with adsorbent (at 80% height).

C. Removal Efficiency of Cadmium

The results indicate cadmium removal trend by SAT for different influent concentrations which indicate almost similar removal efficiencies. The removal efficiency trend for Cadmium was found for without adsorbent as well as with adsorbent case. Results showed that Garden Grass was found to increase the removal efficiency of SAT by 39% which is admirable. It was observed that Loamy Sand soil is more effective in removing Cadmium than Lead when coupled with Garden Grass.

D. Removal Efficiency of Lead

Removal efficiency of Lead by SAT with Garden Grass showed less efficiency, thus it is not very effective in removing Lead. Only 17% average removal efficiency was observed when it was combined with Garden Grass.

V. CONCLUSION

The experimental studies shows that Loamy Sand soil increases the removal efficiency of Cadmium and Lead in conjunction with Garden Grass as adsorbent in between the soil columns. Removal efficiency was observed maximum at the adsorbent height of 80%, showing 82.4% for Cadmium and 57.2%. Loamy Sand soil can be merged with Garden Grass and can used to treat Cadmium 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 cadmium industries.

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REFRENCES

1. Sunil Kulkarni, Sonali Dhokpande, Dr. Jayant Kaware, “A Review on Spectrophotometric Determination of Heavy Metals with emphasis on Cadmium and Nickel Determination by U.V. Spectrophotometry”, International Journal of Advanced Engineering Research and Science, vol. 2, no.9, pp.35-38, 2015.
2. T. Selvakumar , Madhavi Ganesan. **“**Water Quality Improvements in Soil Aquifer Treatment (SAT) Simulated Soil Columns”, Indian Journal of Science and Technology, vol. 8, no. 28, pp.1-6, 2015.
3. Evbuomwan B. O, Atuka M.M, “Kinetics and Thermodynamic Studies of Biosorption of Cadmium (ii) from Aqueous Solution onto Garden Grass (GAG)”, Journal of Chemistry and Materials Research, vol.1, no. 1, pp.12-22, 2014.
4. Lokendra Singh Thakur, Pradeep Semil, “Adsorption of Heavy Metal (Cd^{2+}, Cr^{6+} and Pb^{2+}) from Synthetic Waste Water by Coconut husk Adsorbent”, International Journal of Chemical Studies, vol. 1, no. 4, pp.64-72, 2013.
5. Pushpendra Kumar Sharma, Sohail Ayub, Chandra Nath Tripathi, “Agro and Horticultural Wastes as Low Cost Adsorbents for Removal of Heavy Metals from Wastewater: A Review”, International Refereed Journal of Engineering and Science, vol. 2, no. 8, pp.18-27, 2013.
6. Ghanshyam G. Pandhare, Nikhilesh Trivedi, Rajesh Pathrabe, S. D. Dawande, “Adsorption of Cadmium (II) And Lead (II) from a Stock Solution Using Neem Leaves Powder as a Low-Cost Adsorbent”, International Journal of Innovative Research in Science, Engineering and Technology, vol. 2, no.10, pp.5752-5761, 2013.
7. Nagarajappa D.P, Manjunatha K and Manjunath N.T, “Effects Of Soil Types on Peformance Of Soil Aquifer Treatment (SAT) System”, J. Indian Geotech Conference, pp: 425- 428,2010.

AUTHORS PROFILE

Shivalinga Saboji S. has appeared in final year of M.Tech in Environmental Engineering at UBDT college of engineering, Davangere, Karnataka, India

Dr. Nagarajappa D.P. is the Professor and PG CO-ordinator in Department of Civil Engineering, UBDT College of Engineering, Davangere, Karnataka, India.

Dr. Manjunath N.T. is Professor in Department of Civil Engineering, UBDT College of Engineering, Davangere, Karnataka, India.

Dr. Manjunatha K. is Professor and Chairman in Department of Civil Engineering, UBDT College of Engineering, Davangere, Karnataka, India.