Removal of Aluminium from Simulated Wastewater by Using Soil Aquifer Treatment in Conjunction with Prosopis Julifera Adsorbent

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***Abstract*—Treatment of wastewater for disposal and reuse is necessary for safe and sustainable environment. Several treatment techniques are adopted for better management of wastewater. Soil Aquifer Treatment(SAT) is one such innovative treatment technique for pre-treated wastewater that removes Pollutants, Heavy Metals and gives better quality of water after treatment. This treatment method coupled along with Prosopis Julifera Adsorbent has found to be efficient in removing aluminium from wastewater. Bench scale studies were performed using three different concentrations in water are 10, 20, 30 mg/L with varying adsorbent heights of 20%, 40%, and 60% in 40.96cm soil depth and 10cm adsorbent depth and 10cm of Ponding Depth has maintained. Maximum removal efficiency of 86.65 % was achieved for 60% height of adsorbent in Clayey Silt soil with Prosopis Julifera Adsorbent .**

Keywords- Adsorbent, Ponding depth, Prosopis Julifera, Soil Aquifer Treatment

I. INTRODUCTION

Improved quality of human life and Urbanization is effecting the environment not only by polluting air and land, but also by polluting the present water bodies and which in turn resulted in depletion of the water bodies. Agricultural activities, Industries, Construction, Hydrological modifications, Marine and recreational activities, Onsite wastewater systems, Land development, Transportation are some of the important sources of pollution of water bodies. Safe drinking water is essential to all life forms in order to survive.[1,2,6] Aluminium's occurrence in natural water is controlled by pH and finely suspended mineral particles. Aluminium is nonessential for plants and animal species and are used in treatment of water. Concentrations exceeding 1.5mg/L constitute a toxicity hazard in marine environment, and levels below 200µg/L present a minimal hazard. The United Nations Food and Agriculture Organizations recommended maximum level for irrigation waters is 5mg/L. The possibility of connection between elevated aluminium levels in brain tissues and Alzheimer's disease has been raised. The U.S. EPA secondary drinking water regulations list an optimal secondary maximum contaminant level (SMCL) of 0.05mg/L and maximum SMCL of 0.2mg/L.[9,10]

II. MATERIALS AND METHODOLOGY

A. *Preparation of Adsorbent*

The Prosopis Julifera seed powder was prepared as per procedure given by Venugopal et al.,(2014). Fresh seed pots of Prosopis Julifera is collected from the field washed and dried in oven for 24hours and crushed into fine size. The samples were then washed 5-10 times with tap water and then with distilled water for 2-3 times to eliminate dirt particles and dried at 150^0 for 8hour and then screened through a sieve with a particle size range of 150-300µm. The dried, sieved powder is then stored in a tight lid container for further studies. The adsorbents were placed at 3different heights from the bottom viz.,20%, 40%, 60% in 50.96cm of soil depth. The adsorbents were of 10cm height in the column without compaction.[3,4]

B. *Preparation of Synthetic Wastewater*

The wastewater sample is prepared by using aluminium metal, by dissolving 500mg of aluminium metal in 10ml concentrated Hydrochloric acid by heating gently diluted to 1000ml water. Aluminium Potassium Sulphate palets were diluted to make different known concentrations viz., 20,40,60mg/L for testing performance of Soil Aquifer Treatment system. The prepared wastewater are filled in 20litres influent tanks.

C. *Preparation of Soil*

Clayey silt soil was characterised by the geotechnical properties obtained by the experiments. The dry density of soil was found to be 1.71 g/cm^3 and it was maintained by mixing water and compaction. Experiments were carried for single depth of soil 40.96cm and three heights of adsorbent. A layer of 10cm depth of adsorbent was introduced in the soil column at 20%, 40% and 60% in different trials and experimented.

D. Experimentation

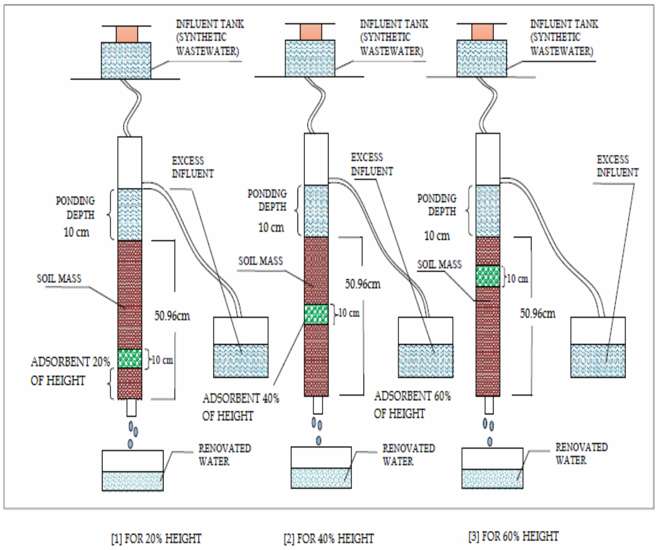

Fig 1. Soil Aquifer Treatment System : Experimental Setup

The experimental set up was as shown in Fig.1.Column studies were conducted in PVC columns of 8inch diameter and 60.96cm length. Clayey silt was used for SAT and filled upto 50.96cm. When conducting experiment with adsorbent, three adsorbent heights were tried at 20%, 40%, 60% of 50.96cm soil depth. Synthetic water to be tested for removal efficiency was passed through overhead tank and a Ponding Depth of 10cm 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.

III. RESULTS

A. Performance of Clayey Silt Soil Without Prosopis Julilfera Adsorbent

Table1 Shows the performance of Clayey silt soil of depth 50.96cm without adsorbent for removal of aluminium.

Table 1. Performance of SAT System Without Adsorbent for Column Soil Depth 50.96cm in Clayey Silt Soil.

Sl no	wastewater Concentration, mg/l	Effluent Concentration, mg/l	Removal Efficiency %
1	10	5.67	43.3
2	20	12.82	35.9
3	30	21.32	28.93

The clayey silt soil was efficient to remove aluminium from influent to some extent. The maximum removal was recorded as 43.3% for 10mg/l initial concentration and least at 30mg/l as 28.93%.

B. Performance of Clayey Silt Soil With Prosopis Julifera Adsorbent at 20% height from the bottom

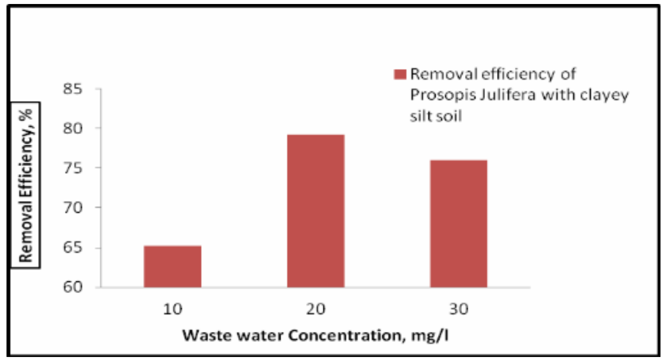

Fig 2. Performance of SAT With Prosopis Julifera at 20% Height From Bottom of Column

Removal efficiency of aluminium by SAT at 10, 20, 30mg/l of influent concentration for 20% adsorbent height form the bottom of the column are shown in Fig 1. The maximum efficiency at 20% height was observed for 20mg/l as 79.2%. The other efficiencies were 65.2%, 76% at 10 and 30mg/l respectively.

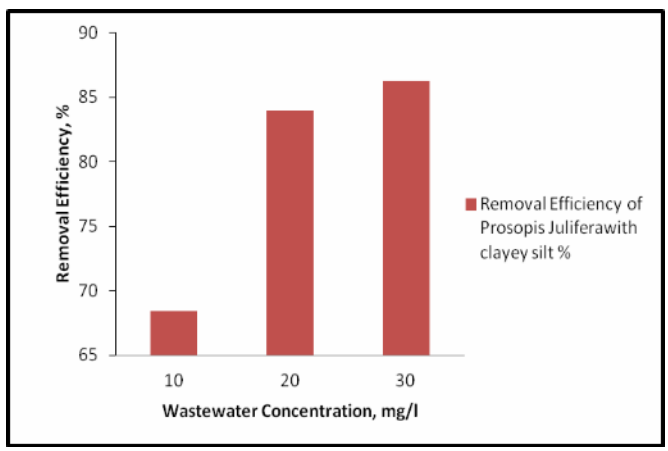

Fig 3. Performance of SAT With Prosopis Julifera at 40% Height From Bottom of Column

Removal efficiency of aluminium by SAT at 10, 20, 30mg/l of influent concentration for 40% adsorbent height form the bottom of the column are shown in Fig 3. The maximum efficiency at 40% height was observed for 30mg/l as 86.26%. The other efficiencies were 68.4%, 86.26% at 10 and 20mg/l respectively.

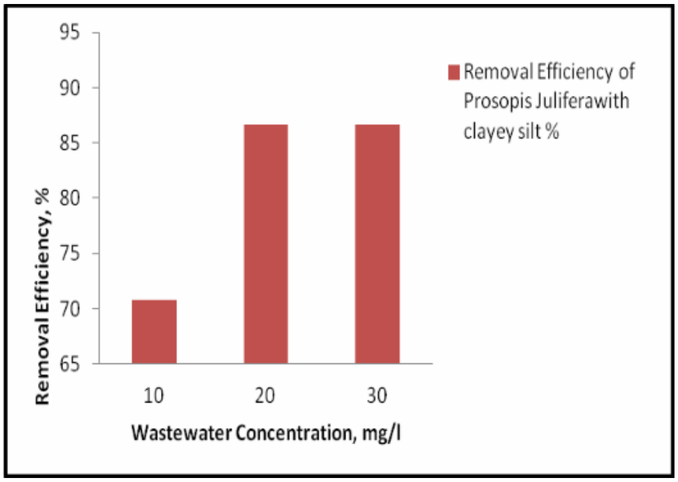

Fig 4. Performance of SAT with Prosopis Julifera at 60% height from bottom of column

Removal efficiency of aluminium by SAT at 10, 20, 30mg/l of influent concentration for 60% adsorbent height form the bottom of the column are shown in Fig4. The maximum efficiency at 60% height was observed for 20mg/l as 86.65%. The other efficiencies were 70.8%, 86.62% at 10 and 30mg/l respectively.

C. Comparison of SAT With Prosopis Julifera and Without Prosopis Julifera

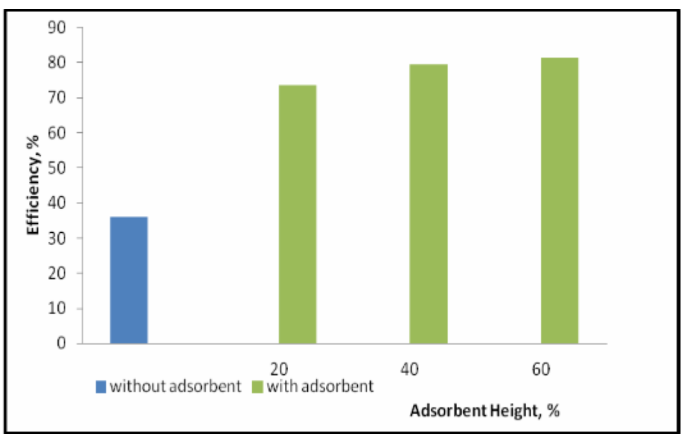

Fig.5. Comparison of Removal of Aluminium By SAT Without and With Adsorbent

The average removal efficiency was considered for each height was varying. The average efficiency at 20% height was 73.46%, at 40% height was 79.55%, and 81.24% at 60% height from the bottom of column as shown in Fig 5. It is commendable that the efficiency was nearly doubled compared to just soil SAT system in each height. The overall average efficiency was calculated taking average values at different influent concentrations. Compared to SAT without Prosopis Julifera which had average removal efficiency of 36.04%, Prosopis Julifera enhance maximum removal efficiency of about 86.62% at 60% height of adsorbent from bottom of column.

IV. CONCLUSIONS

The experimental studies reveal that clayey silt soil enhanced its removal efficiency of Aluminium by the addition of Prosopis Julifera as adsorbent in between the soil column. Almost constant removal efficiency was found for different influent concentrations. Maximum removal efficiency of 86.62% was achieved in adsorbent placement height 60% of 50.96cm soil mass, clayey silt soil can be merged with Prosopis Julifera and used to treat Aluminium contaminated effluents more effectively. This system can be utilized for industrial effluents containing Aluminium and reclaimed water can be used for indirect uses.

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