Removal of Aluminium From Simulated Wastewater By Using Soil Aquifer Treatment in Conjunction With Vachellia Nilotica Adsorbent

Priyanka N[1], Nagarajappa D.P[2], Manjunath K[3], Manjunath N.T[4]
[1, 2, 3, 4] Department of Civil Engineering
[1, 2, 3, 4] University BDT College of Engineering, Davangere-577004, Karnataka, India

Abstract*- Soil Aquifer Treatment method has coupled along with natural adsorbent for treating Aluminium wastewater. Vachellia Nilotica Adsorbent used to enhance the removal efficiency of Soil Aquifer Treatment (SAT) in removal of aluminium. Bench scale studies were performed using three different concentrations in water (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 90.73% was recorded for 40% height of adsorbent in Clayey Silt soil with Vachellia Nilotica Adsorbent.*

Keywords- Adsorbent, Soil Aquifer Treatment (SAT), Vachellia Nilotica

I. INTRODUCTION

Safe drinking water is very essential to human and all other life forms in order to survive. Urbanization and improved quality of human life has affected directly on the environment not only by causing air and land pollution 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,. Etc are some of the important sources of surface water as well as sub surface water bodies.

Aluminium being the third most abundant element on the earth, aluminium will cause many problems on human as well as aquatic life. The average abundance in earth's crust is 8.1%, in soils is 0.9 to 6.5%, in streams it is 400µg/L, in U.S. drinking waters it is 54µg/L, and in groundwater it is less than 0.1µg/L. Aluminium occurs in the earth's crust in combination with silicon and oxygen to form feldspars, micas, and clay minerals. The chief ore of the aluminium is bauxite. Aluminium and its alloys are used for heat exchangers, aircraft parts, building materials, containers, etc. [1,2,5 &6]

II. SOIL AQUIFER TREATMENT TECHNOLOGY

Soil Aquifer Treatment (SAT) is an artificial method of recharging the groundwater aquifer. Water is introduced into the groundwater through soil percolation under certain controlled conditions. This can be used either to extract the freshwater in later stages or as a barrier to prevent saltwater or contaminants from entering into the aquifer. SAT system is based on simple principle of percolation of water through the soil during which, the water under goes natural filtration and enters the aquifer. Due to its natural treatment, Soil Aquifer Treatment has proven as a efficient aquifer management or recharging technique for removal of various metals, dissolved organic matter. [4]

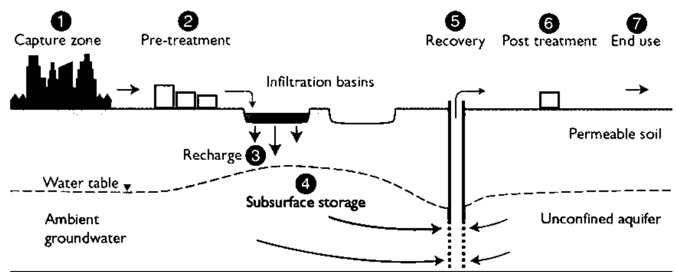

Fig 1. Schematic of Soil Aquifer Treatment (SAT)

Adsorption can be defined as a mass transfer process that includes the binding of 2phases like in liquid to liquid, gas to liquid, liquid to solid , or gas to solid interface where in, material being used is called as Adsorbate and adsorbing substance is called as adsorbent. Adsorption can be adopted as a treatment process to remove highly undesirable contaminants from the feed water as it involves the separation of undesirable compounds from the liquid phase by binding upon the adsorbent surface.[3]

III. MATERILS AND METHODOLOGY

A. Preparation of Synthetic Wastewater

The wastewater sample is prepared by using the aluminium metal, by dissolving 500mg of aluminium metal in 10ml concentrated Hydrochloric acid (Hcl) 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.

B. Adsorbent Preparation

The Vachellia Nilotica seed powder was prepared as per procedure given by Geetha et al.,(2008). The fresh seed pots of Vachellia Nilotica was collected dried for 24hours in oven and then charred. The samples were then washed 10-12 times with tap water and then with distilled water for 3-4 times to eliminate dirt particles and dried at 1100 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.

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/cm3 and it was maintained by mixing water and compaction. Experiments were carried for single depth of soil 40.96cm and 3heights 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.2 shows the experimental set up of Soil Aquifer Treatment. 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.

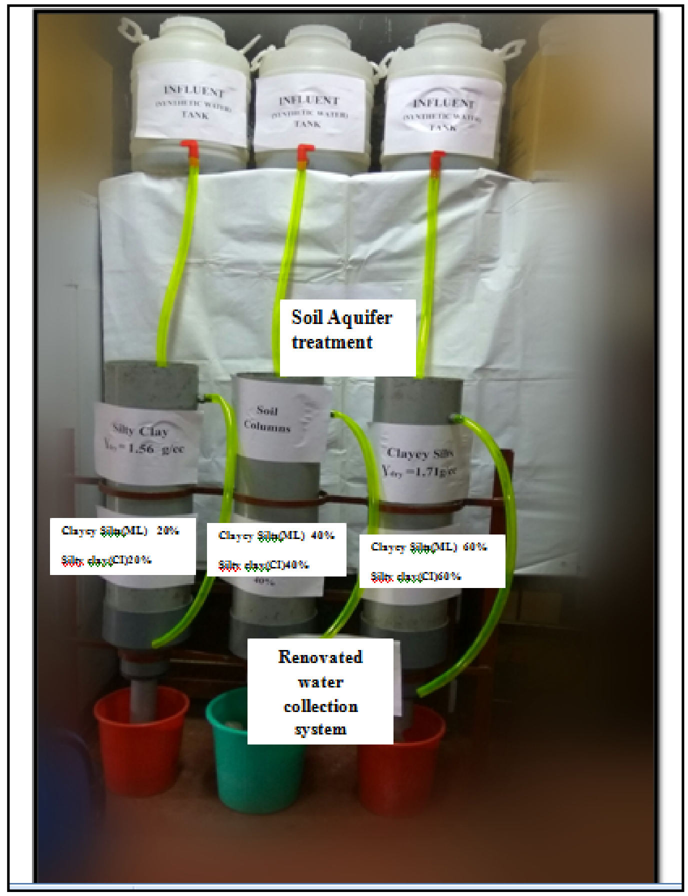

Fig.2 Soil Aquifer Treatment System : Experimental Setup

IV. RESULTS AND ANALYSIS

A. Performance of Clayey Silt Soil Without Vachellia Nilotica Adsorbent

Table 1. 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 Vachellia Nilotica Adsorbent at 20% height from the bottom

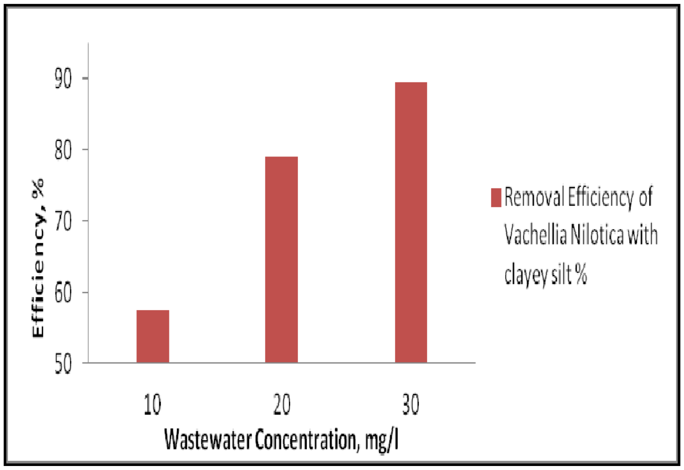

Fig 3. Performance of SAT with Vachellia Nilotica at 20% height from bottom of column

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 3. The maximum efficiency at 20% height was observed for 30mg/l as 89.46%. The other efficiencies were 79.1%, 57.6% at 20, 10mg/l respectively.

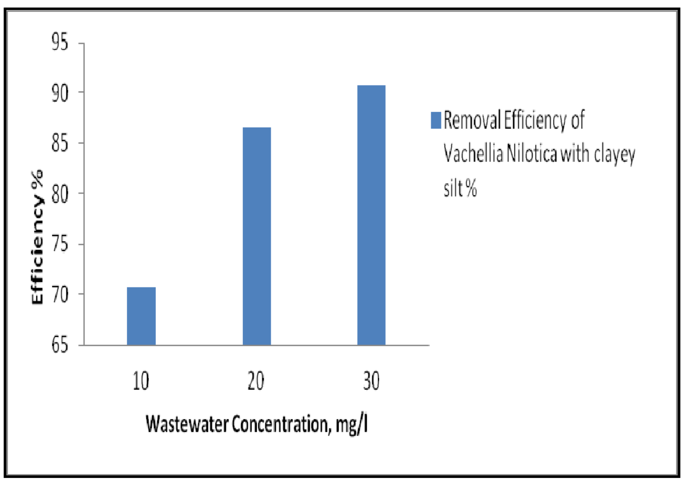

Fig 4. Performance of SAT with Vachellia Nilotica at 40% height from bottom of column

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 4. The maximum efficiency at 40% height was observed for 30mg/l as 90.73%. The other efficiencies were 70.8%, 86.65% at 10, 20mg/l respectively.

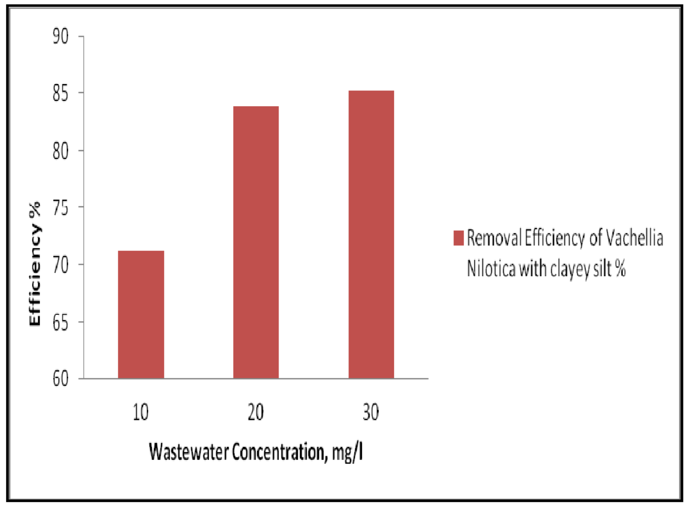

Fig 5. Performance of SAT with Vachellia Nilotica at 60% height from bottom of column

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 Fig 5. The maximum efficiency at 60% height was observed for 30mg/l as 85.26%. The other efficiencies were 71.2%, 83.95% at 10, 20mg/l respectively.

C. Comparison of SAT with Vachellia Nilotica and without Vachellia Nilotica

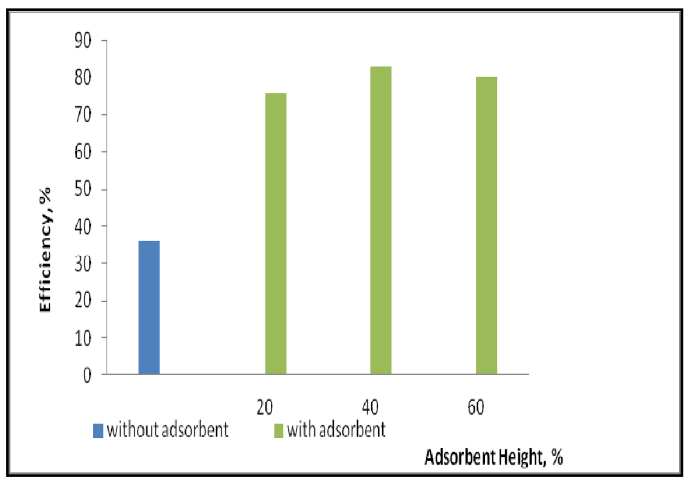

Fig.6. Comparison of removal of Aluminium by SAT without and with adsorbent

The average removal efficiency was considered for each height was varying. The average efficiency at 20% height was 75.39%, at 40% height was 82.72%, and 80.13% at 60% height from the bottom of column as shown in Fig 6. 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

Vachellia Nilotica which had average removal efficiency of 36.04%, Vachellia Nilotica enhance the efficiency very effectively.

V. CONCLUSIONS

The experimental studies reveal that clayey silt soil enhanced its removal efficiency of Aluminium by the integration of Vachellia Nilotica as adsorbent in between the soil column. Almost constant removal efficiency was found for different influent concentrations. Maximum removal efficiency of 90.73% was achieved in adsorbent placement height 40% of 50.96cm soil mass, clayey silt soil can be merged with Vachellia Niloticaand 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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