Domestic Wastewater Treatment by Soil Aquifer Treatment Using Corn cobs

Sharada D K, Nagarajappa D P, Shiva Keshav Kumar P, Manjunath NT

***Abstract*—Soil aquifer treatment (SAT) is a geo purification system which is increasingly adopted as a useful secondary means to reliably enhance water resources and reduce indiscriminate discharge of treated wastewater to water bodies. In their quest for alternative water sources, several communities in arid and semi-arid regions of the world have considered wastewater treatment as an integral part of their water supply options. Conventional wastewater-treatment technologies are cost-intensive and often pose financial constraint in developing countries. Therefore, considerable attention has been directed towards design and development of low-cost wastewater management technologies coupled with recycle and reuse benefit. In the present research work, column studies were conducted to treat domestic wastewater by using Soil Aquifer Treatment in conjunction with adsorbent. The adsorbent used for experiment is corn cobs. The variables considered for experimental work were type of soil and positioning of adsorbent. The removal efficiencies of water quality parameters observed are pH, Total solids, Total dissolved solids, Chlorides, Chemical oxygen demand, Total Kjeldahl nitrogen. The column containing silty sandy soil with adsorbent positioning at 50% from the bottom showed more efficiency.**

***Index Terms*— Adsorbent, Chlorides, COD, Total Kjeldahl Nitrogen.**

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I. INTRODUCTION

Currently, there is a growing awareness of the impact of sewage contamination on rivers and lakes. Disposal of untreated treated wastewater to lakes, streams and land is globally increasing at staggering volumes, especially in developing countries due to rapid population growth, urbanization and lack of investments to construct, operate and maintain conventional wastewater treatment plants. Soil aquifer treatment (SAT) has been successfully employed worldwide for wastewater treatment and reuse. It utilizes soil strata to produce water of acceptable quality for intended use. Treatment benefits during SAT are achieved during infiltration of wastewater effluent initially through the unsaturated zone and eventually in the saturated zone in the aquifer where it mixes with the native groundwater before it is recovered via a production well for reuse.

According to Kanarek and Michail (1996), removal of organic compounds, nitrogen, phosphorus, suspended solids, bacteria and viruses in SAT system is achieved through infiltration, percolation, sorption, chemical reaction, biotransformation, die-off and predation.[1]

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Yona Nelson Malolo (2011) studied on effect of temperature and redox conditions on the removal of contaminants during soil aquifer treatment. The findings of this research confirm that SAT systems are able to act as a reliable barrier for DOC, nitrogen, and phosphorous regardless of seasonal and flow conditions during SAT providing a sufficient retention time is maintained.[2].

To characterize the wastewater effluents obtained from the wastewater treatment plants of seven different plants the soil batch and column experiments were conducted at Jonnam region situated in South Korea with the intension of determining the effluents for best use of Soil aquifer treatment in South Korea. Depending on reaction time the concentrations of BDOC fraction and the residual DOC for the effluents obtained ranged from 19.4 to nearly 60% and from 1 mg/l to 7.5 mg/l, respectively.[3] Ali et al(2014) studied the Industrial Wastewater treatment by fixed bed column technique using low cost adsorbents. He used the corn cobs as plant wastes adsorbent which is locally available. Two variables (contact time and pH value) were considered. Maximum removal efficiency of 99.90% for Ni was observed at pH of 6.5 and 2.38 hr. The least removal efficiency of 91.35% for Zn occurred at pH 6.5 and 0.15 hr. Along with heavy metal parameters were also removed .Removal efficiency for TSS, TDS and COD were 66%, 56%, and 83.4% respectively[4].

II. METHODOLOGY

To evaluate the performance of SAT system in treating domestic wastewater in conjunction with adsorbent column studies were carried out. The geotechnical properties of soil were done and classified as Silty Sandy soil and Clayey Sandy soil. Physico chemical properties of soil were done. The corn cobs were collected from near farms and then treated as per the procedure given in literature. Domestic wastewater was collected from nearby drain flowing in Vinoba Nagar located in Davangere city. The initial characteristics of soil were checked. Totally three pipes of each 5 inches diameter and 1.5m length were used as columns. To prevent the escape of soil at the bottom of column mesh was provided. Further the reducer was fitted to the plug to enable smooth collection of effluent and the columns were mounted on the stand. The soil was filled in the column and the adsorbent was placed at 25, 50, 75 % positioning of column .Wastewater to be tested was maintained above the column for 30cm. For each predetermined condition of experimentation, the soil and the adsorbent were freshly filled in the column. The renovated

ISSN: 2278 – 7798

wastewater was collected and analyzed for various parameters.

Plate 1: Experimental Setup of SAT

III. RESULT AND DISCUSSION

A. Soil Characterization

The soil samples collected from different sites were analyzed and were classified into Silty sand and clayey sand .

Table 1: Geotechnical Properties of the soils used for experimentation

Sl.No	Parameters	Sample A	Sample B
1	In-situ dry density(gm/cc)	1.61	1.68
2	Specific Gravity	2.3	2.4
3	Differential free Swell %	20	40
4	Liquid Limit%	22.6	41.8
5	Plastic limit%	Non-plastic	28.1
6	Plasticity Index	Non-plastic	13.7
7	Compaction test γdgm/cc OMC %	2.24 8	1.82 11.6
8	Sieve Analysis % of Gravel % of Sand % of Silt & Clay Cu Cc	0.84 58.66 40.5 3.13 0.95	0.00 32.6 67.4 2.823 0.861
9	Hydrometer Analysis % of Clay % of Silt	15.5 25	40 27.4
10	Permeability(cm/sec)	0.00163	3.8070×10[illegible]
	Soil Classification	Silty Sandy Soil -SM	Clayey Sandy Soil-SC

B. Preparation of Corn Cobs

The corn cob was treated as per the literature review. Raw corn cobs were collected from nearby farms. It was then crushed by grinder and washed with water and kept 24 hrs for drying. This procedure was repeated three times for all the apparent excess material and color removal. After washing the corn cobs were treated with 10% Hcl for 6hrs at 30^0 c for chemical modification. Modified corn cobs were then washed with distilled water and oven dried at 60^0c for 24 hrs. The obtained corn cobs were sieved with sieve size of 2mm and 1 mm respectively.

C. Positioning of Adsorbents

To access the effect of performance of SAT system in treating domestic wastewater the adsorbent of 10 cm was placed at 25%, 50%, 75 % from the bottom of the column.

D. Performance of Sat without Adsorbents

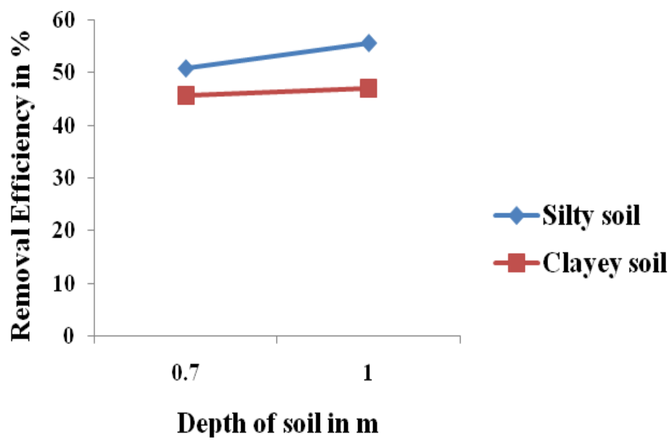

Fig 1: SAT Removal Efficiency of TS without Adsorbents

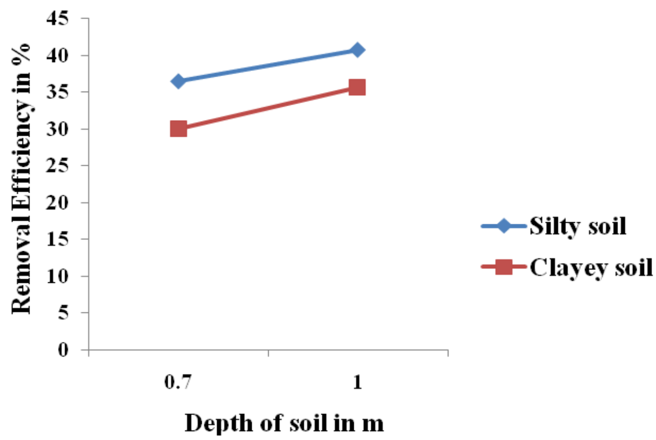

Fig 2: SAT Removal Efficiency of TDS without Adsorbents

ISSN: 2278 – 7798

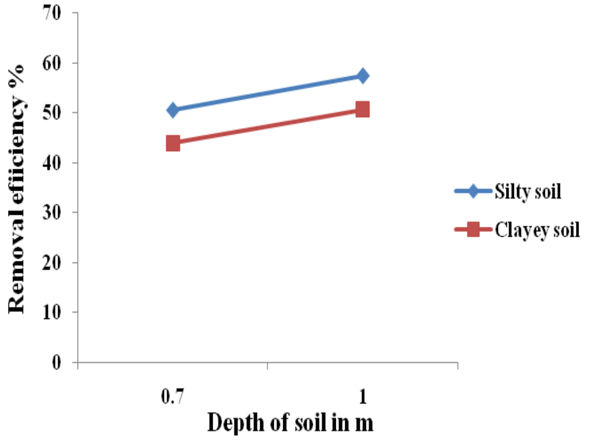

Fig 3: SAT Removal Efficiency of Chlorides without Adsorbents

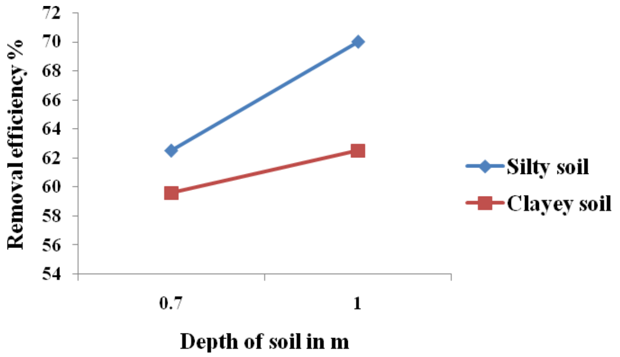

Fig 4: SAT Removal Efficiency of COD without Adsorbents

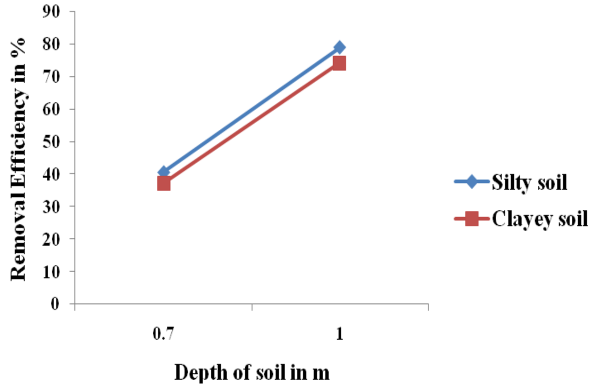

Fig 5: SAT Removal Efficiency of TKN without Adsorbents

E. Performance of Sat in Conjunction Adsorbents

The results of experimentation under varied experimentation conditions like depth of soil and type of soil and positioning of adsorbent (corn cobs) as shown in figure.

For each experimental setup, the varied experimental conditions are indicated in the title of respective table. The bar charts are drawn thereafter with their results.

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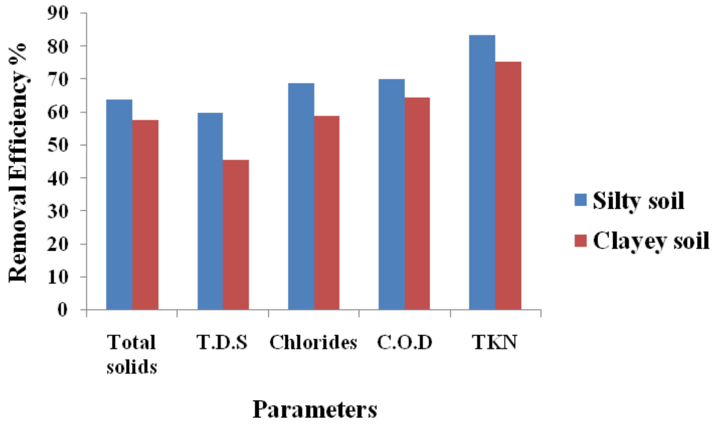

Fig 6: SAT Efficiencies of all Parameters with Corn Cobs as Adsorbent Placed 25 % Depth from Bottom

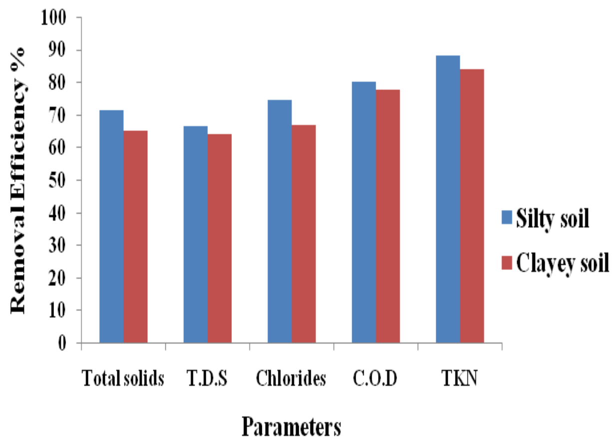

Fig 7: SAT Efficiencies of all Parameters with Corn Cobs as Adsorbent Placed 50 % Depth from Bottom.

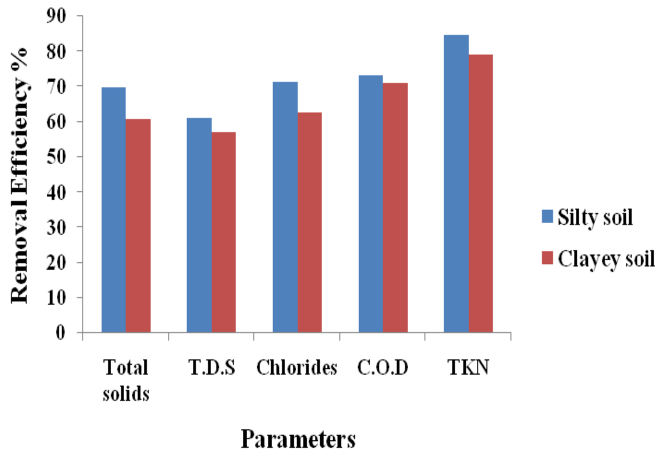

Fig 8: SAT Efficiencies of all Parameters with Corn Cobs as Adsorbent Placed 75 % Depth from Bottom.

ISSN: 2278 – 7798

IV. Conclusion

The silty soil with 1.0m depth showed maximum removal efficiency in all parameters. The use of corn cobs as adsorbent positioning at 50% from the bottom showed maximum removal efficiency. Thus it is inferred that soil in conjunction with adsorbent showed maximum removal efficiency compared to soil without adsorbent. Clayey soil with corn cobs as adsorbent positioning at 25% from the bottom showed less removal efficiency. Because the High sodium concentration clay bearing soil disperses soil particles, and leads to decrease in soil permeability. Thus the clayey soil does not result on effective treatment of domestic wastewater. SAT system in conjunction with adsorbents is more efficient in removing pollutants.

REFERENCES

[1] A. Kanarek, M. Michail, Groundwater recharge with municipal effluent: Dan region reclamation project, Israel. *Water Science and Technology*, 34(11),pp : 227-233, 1996.

[2]Yona Nelson Malolo Effect of Temperature and Redox Conditions on the Removal of Contaminations During Soil Aquifer Treatment .Institute for Water Education, pp: 4-146, 2011.

[3] W.Cha, H Choi, J .Kim. and I.S. Kim, Evaluation of Wastewater Effluents For Soil Aquifer Treatment in South Korea, *J. Water Science and Tec*h. 50(2), , pp: 315-322, 2004.

[4] Khalid Ali and R.M . Majid, The Removal of Zinc, Chromium and Nickel from Industrial Wastewater using Corn Cobs. *J. Science*, 55, pp: 121-131. 2014.

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ISSN: 2278 – 7798