Investigative Study on the Treatment of Domestic Wastewater by Soil Aquifer Treatment (SAT) in Conjunction with Cashew Nut Shell Adsorbent

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Abstract- *In the present work, Cashew nut shell was used to enhance the removal efficiency of Soil Aquifer System (SAT) for the removal of Pollutants present in the Domestic Wastewater. The column studies were carried out using Domestic Wastewater and varying adsorbent heights (25%, 50% and 75%) in 1.0m soil depth. Soil properties were determined and Clayey Sandy Soil was used. The efficiency of SAT to remove TS, TDS, Cl, COD and TKN without Cashew Nut Shell resulted in 49.89%, 51.23%, 48.73%, 55.15% and 52.00% respectively. The conjunction of Cashew Nut Shell in SAT resulted in increased removal efficiency. Whereas the efficiency was observed maximum at 50% height of adsorbent resulting 68.50%, 70.00%, 62.48%, 65.80 and 62.18 for TS, TDS Cl, COD and TKN respectively. Comparison studies show that SAT in conjunction with Cashew Nut Shell showed better performance than without adsorbent one.*

Keywords- TS, TDS, Cl, COD, TKN, Cashew Nut Shell,SAT, Domestic wastewater.

I. INTRODUCTION

Water management practices are the progressively turning into a difficulty of major concern as fresh water resources are diminishing. To decrease the consequences of the pollution on water bodies and the wastewater that is generated wants to be treated and effluents correctly disposed of. Effluents from treatment plants are typically disposed of in to water bodies but they could also be used to recharge groundwater resources if they properly handled. Treatment of wastewater throughout the infiltration involves physic–chemical process and biological process for the removal of contaminants present in the effluent (Hellen Michelle)[1].

The uncontrolled disposal of solid, liquid and gaseous waste coming out from the municipal, Industrial and agricultural process to environment are the most harmful effects to the sustainability of human culture, society and health by contaminating air, water and land contributing to the global warming. Numerous conventional and modern technologies are available for treatment and disposal of municipal wastewater. Conventional primary and secondary treatment management techniques are designed to disposal of treated wastewater either in to public sewers, or for irrigation. 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].

Wastewater consist broad range of contaminants that potentially spoil ecological resources particularly water bodies. The constitution and concentration of wastewater vary according to the characteristics of the wastewater generated by the communities. Suspended solids are when discharged to water bodies they have a propensity to form slush deposits and anaerobic situation. Biodegradable organics reduces (DO) dissolved oxygen during decaying of organic matter by microorganisms and creates septic condition when all oxygen is consumed. Wastewater contains nutrients – nitrogen along with phosphorous and is discharged to the water bodies causes eutrophication of surface water bodies and ground water pollution. The pollutants such as arsenic, lead, mercury, benzene may have toxic, carcinogenic, mutagenic, and teratogenic harmful effects [1].

This study infuses SAT with Cashew Nut Shell to treat Domestic Wastewater 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

Neema P.et al. [3] the pilot study was carried out for renovation of primary treated municipal wastewater by Soil Aquifer Treatment (SAT). The performance data indicated that SAT has a very good potential for removal of organic pollutants, nutrients as well as bacteria and viruses. The SAT system was found to be more efficient and economical than the conventional wastewater treatment systems and hence recommended for adoption.

Akber A et al. [4] was carried out the study on SAT to modernize tertiary treated wastewater to standard used for irrigation. Collected samples were analyzed for pH, total suspended solids (TSS), phosphate (PO4), nitrate (NO3), ammonia (NH3), biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total bacteria, coliform, E. coli and S. faecalis. The obtained results indicate 90%, 99%, 90%, 99.6%, 99%, 99%, 100%, 100% and 100% removal of suspended solids, BOD5, COD, PO4, NH3, NO3, total bacteria, coliform and E. Coli, respectively.

Sweetlin Rajula Rubavathi et al.[5] studied the adsorption performance of low cot adsorbent Cashew nut shell which is used for removal of methylene blue dye from the wastewater. The varieties of experimental parameters are determined by using batch adsorption technique. The efficiency of dye removal is increased with decrease in initial concentration of dye and also increased with increase in contact time and amount of adsorbent.

III. METHODOLOGY

A. Adsorbent Preparation

Cashew nut shell adsorbent as prepared as per Sweetlin Rajula Rubavathi et al. The cashew nutshell is washed with distilled water to remove dirt and dust particles. It is grinded to 300-800µmparticles. The particles are oven dried at 170^{o}C for 24 hours and it is cooled to room temperature. The prepared cashew nut shell is as shown in plate 3.3 is used as adsorbent.

B. Source of Wastewater

The wastewater is used for this experiment is to investigate the treatment efficiency of Soil Aquifer Treatment (SAT) system under various experimental conditions. The Domestic Wastewater used for this study was collected from a drain flowing Near Vidhyarthi Bhavan, Davanagere. It was prepared and filled in 20 litres influent tank. Table 1 shows the characteristics of influent domestic wastewater.

Table 1: characteristics of influent domestic wastewater

Sl no	Parameters	Values
1	**pH**	6.7
2	**Total Solids**	1820
3	**Total Dissolved Solids**	520.96
4	**Chlorides**	277.9
5	**COD**	380
6	**TKN**	50.66

All units are in mg/l except pH

C. Preparation of Soil

Clayey Sandy Soil was characterized by the geotechnical properties obtained by the experiments. The dry density of soil was found to be 1.72 g/cm^3 and it was maintained by mixing water and compaction. Experiments were carried for single depth of soil 1.0m and 3 heights of adsorbent. A layer of 10 cm adsorbent was introduced in the soil column at 25%, 50% and 75% in different trials and experimented.

D. Experimentation

Column studies were conducted in PVC columns of 5 inches diameter and 1.5m length. Clayey Soil was used for SAT and filled up to 1.0m depth. When conducting experiment with adsorbent, 3 adsorbent heights were tried from bottom at 25%, 50% and 75% of 1.0m soil depth. Domestic 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 effluent concentrations were tested. For each predetermined condition of experimentation, the soil was filled afresh in the olumn.

IV. EXPERIMENTAL RESULTS

A. Performance of Clayey Sandy soil without Cashew Nut Shell adsorbent

Table.2. Shows the performance of Clayey Sand soil of 1.0mdepth without adsorbent.

Sl no	Parameters	Influent	Effluent	Removal Efficiency %
1	**pH**	6.7	7.07	
2	**TS**	1820	912	49.89
3	**TDS**	520.96	254.07	51.23
4	**Cl**	277.90	142.5	48.73
5	**COD**	380	178	55.15
6	**TKN**	50.66	34.31	52.00

All units are in mg/l except Ph

Table.2 shows the performance of SAT system without adsorbent. The Clayey Sand soil was used to remove the TS, TDS, Cl, COD and TKN which are present in the domestic wastewater. It was recorded that the Clayey soil removes TS 49.89%, TDS 51.23%, Cl 48.73%, COD 55.15% and TKN 52.00%. The values were recorded at optimum values which were calculated by saturation studies. shows the performance of SAT system without adsorbents.

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

Fig 1 show performance of Clayey sandy soil for 0.9m depth with adsorbents at different height. The Clayey soil with adsorbent Cashew Nut Shell at 25% height is observed remove all parameters efficiently. The maximum removal efficiency of TS, TDS, Cl, COD and TKN recorded are 65.36%, 67.80%, 59.85%, 62.69% and 59.00% respectively with cashew nut shell adsorbent. With practical limitation, removal efficiency of all parameters in Domestic Sewage wastewater was recorded without great difference.

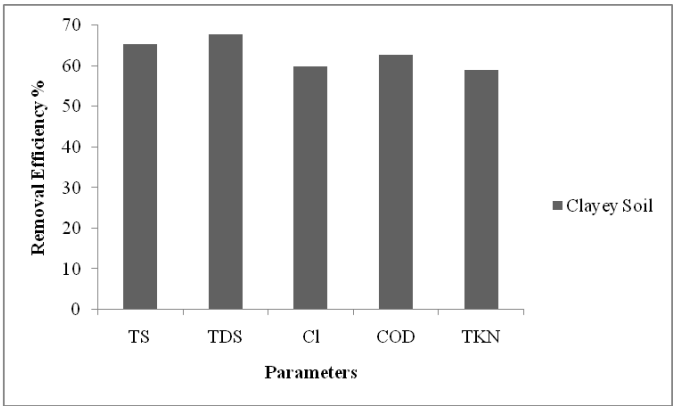

Fig.1. Removal Efficiencies of all Parameters for Clayey Sand Soil with Cashew Nut Shell adsorbent at 25% height.

Fig 2 show performance of Clayey sandy soil for 0.9m depth with adsorbents at different height. The Clayey soil with adsorbent Cashew Nut Shell at 50% height is observed remove all parameters efficiently. The maximum removal efficiency of TS, TDS, Cl, COD and TKN recorded are 68.50%, 70.00%, 62.48%, 65.80% and 62.18%respectively with cashew nut shell adsorbent. With practical limitation, removal efficiency of all parameters in Domestic Sewage wastewater was recorded without great difference.

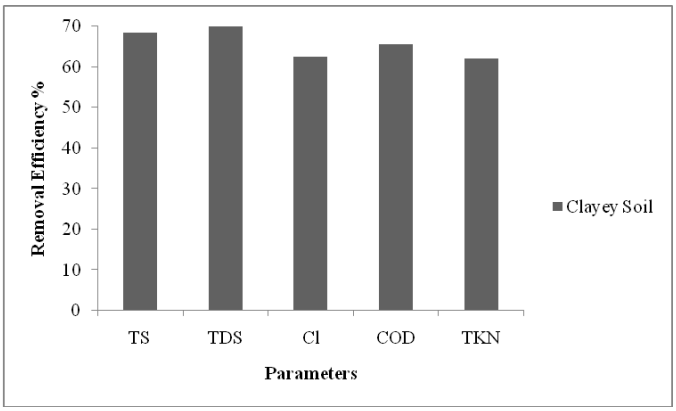

Fig.2. Removal Efficiencies of all parametes for Clayey Sand Soil with Cashew Nut Shell adsorbent at 50% height.

Fig 3 show performance of Clayey sandy soil for 0.9m depth with adsorbents at different height. The clayey soil with adsorbent Cashew Nut Shell at 75% height is observed remove all parameters efficiently. The maximum removal efficiency of TS, TDS, Cl, COD and TKN recorded are 67.00%, 68.45%, 61.00%, 64.15% and 60.20% respectively with cashew nut shell adsorbent. With practical limitation, removal efficiency of all parameters in Domestic Sewage wastewater was recorded without great difference.

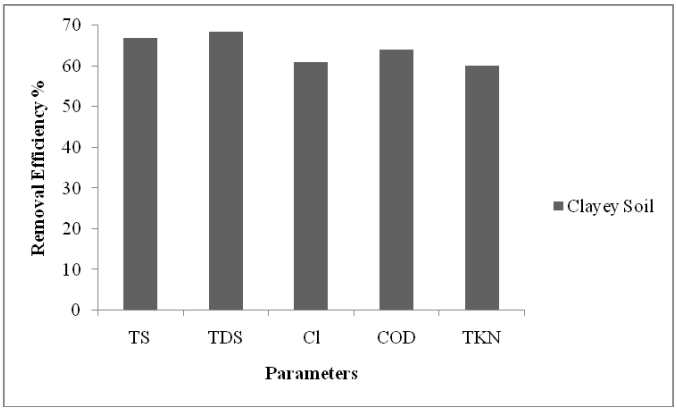

Fig.3. Removal Efficiencies of all parameters for Clayey Sand Soil with Cashew Nut Shell adsorbent at 50% height.

The maximum removal efficiency was observed in 50% height of the adsorbents from the bottom of the column. Fig.4. shows the comparison for performance of SAT for removal of all parameters without adsorbent and adsorbent at 50% height. From the statistics, removal of all parameters is significantly increased by combining it with Cashew Nut Shell. The results showed that Cashew Nut Shell increases the removal efficiency of SAT above 40% which is admirable. It was observed that Clayey Sandy Soil is more effective in removing all parameters in conjunction with Cashew Nut Shell adsorbent.

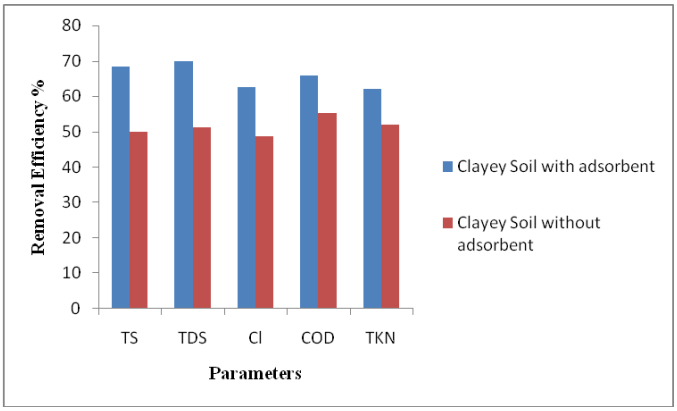

Fig.4. Comparison of removal of all parameters by SAT without and with adsorbent (at 50% height).

V. CONCLUSIONS

The experimental studies show that Clayey Sand soil increases the removal efficiency of TS, TDS, Cl. COD and TKN in conjunction with Cashew Nut Shell as adsorbent in between the soil columns. Removal efficiency was observed maximum at the adsorbent height of 50%, showing TS, TDS, Cl, COD and TKN recorded are 68.50%, 70.00%, 62.48%, 65.80% and 62.18% respectively with adsorbent. Clayey Sand soil can be merged with Cashew Nut Shell and can used to treat contaminated effluents more effectively. Thus results obtained can be utilized for further studies by different strength of Wastewater and also it can therefore be used in treatment of effluents from industries, thereby reducing the level of water pollution from domestic wastewater and industries.

VI. ACKNOWLEDGMENT

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