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Design of Constructed Wetlands for Greywater Treatment

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ABSTRACT: The purpose of this study was to design of constructed wetlands for grey water treatment, explains briefly about the necessity of treatment and types of treatment used in general. Further constructed wetland process, types and advantages of constructed wetland are discussed. For the test beds vetiver and canna plants were selected. The root development of vetiver was deep and wide spread compared to canna. Provide artificial mini wetland and to measure the effectiveness of constructed wetland treatment system. Study was also conducted to evaluate the effect of plant through comparing removal efficiency of the planted and unplanted constructed wetland system. Test bed was planted with vetiver in 20mm gravel root zone media and another set up without plants was maintained as a control constructed wetland was subjected to a flow rate corresponding to hydraulic retention time of 2, 4 and 6 days respectively. The removal efficiency achieved for 79.44% BOD, 83.65% COD, 33.31% Nitrate, 34.54% phosphate, 88.78% SS and 51.99% turbidity for 6 dyas vetiver grass and 74.82% BOD, 79.14% COD, 42.28% Nitrate, 32.93% phosphate, 83.15% SS and 51.99% turbidity for 6 days canna grass.

KEYWORDS: Constructed wetland, Retention time, Grey water, Vetiver, Canna.

I. INTRODUCTION

Constructed wetlands are artificial treatment methods for all type of wastewater to improve the water quality of point and nonpoint sources. The wastewater treatment by constructed wetlands is low energy consumption, low cost and less operation is required. The main function of wetlands to improve the water quality, storage of flood, nutrients cycling, wildlife habitat, active and passive recreation, research, enhancement of landscape and aesthetic view.

Constructed wetland encompasses the substrates, water and vascular plant, substrates consists of sand, gravel and soil, they support living organisms in constructed wetlands. Permeability of substrates affects the water movement through the wetlands and substrates hold the many pollutants and also chemical and biological changes takes place. The limitations of constructed wetlands generally required large areas than the conventional wastewater treatment method. Constructed wetlands also combined with the conventional treatment system. It is economical when land area is available. Efficiency of wetland treatment is varying in the environmental condition, wetlands are a continuous process in all the seasons but in summer lose huge amount of water through evaporation.

For better performance of constructed wetland operation and maintenance is important. Providing broad opportunity for contact of the microbial community with the water and with the sludge and litter, flows reach all parts of the wetland should assured, manage the healthy environment for microbes and growth of vegetation. Selection of vegetation in constructed wetland is one of the important components related to the treatment process and design of constructed wetland. The main focus on suitable vegetation selection in constructed wetland system depends on the wetland design type. Size of constructed wetland depends on size of root zone media, depth of water, hydraulic retention time, aspect ratio, type of feed and hydraulic loading rate. Previous researchers have shows that, the importance of naturally developing plants which help in break down complex substances, converting into toxic and non-toxic substance, demolish pathogens, viruses, pumping oxygen, removing oil spills and PH values controlling. Constructed wetlands use to treat effluents is not latest idea. Constructed wetlands can be treated as natural and inexpensive treatment for domestic, agriculture and industrial wastes. This system can be set up for a single household as well as mass of households generally at a very low cost. The working system is that wastewater passes through constructed wetlands and cleaner water exits the system at same level of entry. Thoroughly electricity and heavy equipments are not required for this system works under the force of gravity. System of Constructed Wetland Components are Granular media (Substrate), Wetland plants, Living organisms, But The important part of artificial constructed is granular media which can be either aggregate, soil and sand or combination of all. Wetland plant may be either free floating type or emergent isdetermined based on the type of wetland used.

II. EXPERIMENTAL SETUP

Figure 1. Photographic View of Artificially Constructed Wetland Setup

The study is carried out in integrated horizontal flow constructed wetlands, with inlet and outlet arrangements. The wetland cell is made up of acrolithic sheet of 5mm thick, with size 0.7 m × 0.3 m × 0.45 m. The total cell is filled with crushed stones which are retained on 20mm sieve size. Wastewater is fed into the cell through influent tank and the mode of operation is batch. The vegetation used is vetiver Zizaniodies which serves two purpose, removal of nitrogen and phosphorous and providing oxygen at the root zone for decomposition of organic matter.The entire setup was placed on roof and wastewater was feed into the system at regular interval of time.The wetland vegetation was planted in the cell 15 days before the wastewater was feed into it.

To do the exhibition check of built wetland, to decide the pollution boundaries, a seat scale study was finished by developing the wetland lake of following measurements. The wetland lake was built of acrylic sheet of 5mm thickness. The plans boundaries are as per the following:Length of the tank = 0.7m. Width of the tank = 0.3m. Depth of the tank = 0.45m. Total volume = 0.0945 m^3.Nearly 40% of volume, wastewater can be hold in the wetland cell that is 0.0378 m^3/day.

To decide the exploratory stream rate, stream rate investigation was completed. The cycle incorporates:

Figure 2. Photographic view of experimental flow Front View of Wetland Pond Before plantation.

III. EXPERIMENTATION

Planned Wetland Lake is filled totally with squashed stone totals of 20 mm distance across size. To decide the volume of water that occupies into the void spaces and furthermore the absolute volume of water that that wetland lake can hold at a time. The next step is filling the entire pond with water to determine the total flow that can be feed into it per day, using a measuring jar to determine in flow in litres.Experimentally the flow rate was found to be 40 litres/day. Hence wastewater sample of 40 litres/day is required to be fed into the wetland pond for retention period of 1 day.

Figure 3. Photographic view of experimental flow Front View of Wetland Pond After plantation

As the retention time selected for work is 2 days wastewater required to be feed is 20 litres/day, for retention time of 4 days the wastewater to be fed is 10 litres/day, and for 6 days retention period the quantity of wastewater feed into the pond is 6.5 litres/day.

The different qualities and boundaries of a coordinated built wetland framework incorporates bed measurements, bed profundity, channel media, plant species, type of wastewater, method of activity lastly the pressure driven maintenance time.

The entire Wetland system works on gravitational force no external force is required to pass the water through their beds. The hydraulic retention time of the waste water in the wetland pond being 2 days wastewater is fed into the system at each days start and the corresponding effluent for 2days retention time is collected the next day by feeding the same quantity of wastewater in and treated water out comes from the wetland pond.

At the exact middle of the pond a separator with small openings at bottom is provided such that the water when enters the pond does no flow directly towards the outlet such that fresh water retains in the wetland pond and treated water flows outside the wetland pond. For this reason it is recommended to build a separating wall with small openings at the bottom when wetlands are constructed in larger scales.

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IV. OBESERVATIONS AND RESULTS

Grey water characteristics are mainly influenced by lifestyle, social, & cultural behavior of water users, availability of water, its characteristics and consumption. Grey water generated from the study area was analyzed for physico-chemical and microbiological parameters. The physico-chemical parameters analyzed were pH, BOD, COD, TSS, TDS, nitrates and phosphates.

The main objective of study is to investigate the performance of artificially constructed horizontal flow wetland planted with vetiver and canna grass. The reductions in pollutional parameters present in municipal wastewater at inlet and outlet of wetlands are determined. The experiment was conducted initially influent wastewater parameters such as pH, Turbidity, Electrical conductivity, chlorides, BOD, COD, Nitrates, Phosphates, Total solids, Total suspended solids, Total dissolved solids and their respective effluent parameters are determined keeping the hydraulic retention time at 2days, 4days and 6days.

Average Percentage Removal of all Parameters:Average percentage removal of all parameters summarized with retention time of 2 days, 4 days and 6 days for vetiver and canna species are listed below table and graph.

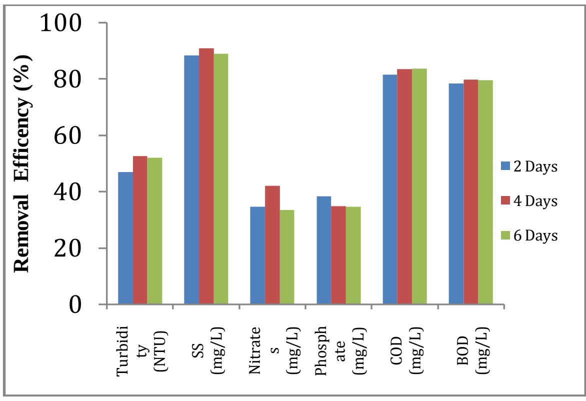

Figure 4(a)

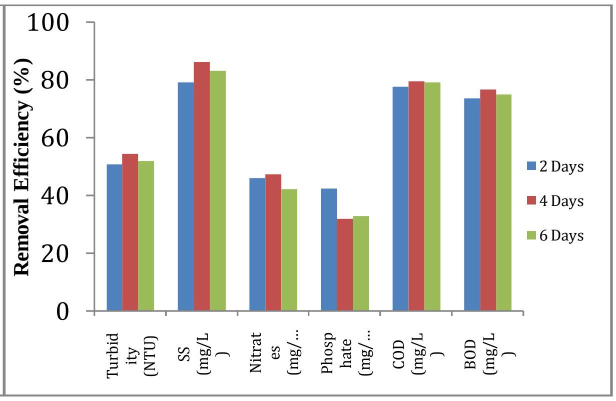

Figure 4(b)

Figure 4(a) and 4(b) Shows Average removal efficiencies of all parameters with Vetiver and Canna respectively

Table 1. Average percentage removal efficiencies of all parameters of vetiver and canna species.

Parameters	**Vetiver**			**Canna**		
	2 Days	**4 Days**	**6 Days**	**2 Days**	**4 Days**	**6 Days**
Turbidity (NTU)	46.97	52.48	51.99	50.75	54.43	51.99
SS (mg/L)	88.21	90.86	88.78	79.15	86.21	83.15
Nitrates (mg/L)	34.66	41.95	33.31	45.99	47.36	42.28
Phosphate (mg/L)	38.25	34.68	34.54	42.32	31.92	32.93
COD (mg/L)	81.49	83.47	83.65	77.49	79.51	79.14
BOD (mg/L)	78.28	79.69	79.44	73.63	76.58	74.82

V. CONCLUSION

Evolved from the test conducting on influent and effluent of various parameters of grey water in artificial constructed wetland the following conclusion are made.Constructed wetlands are low cost and efficient treatment technique for grey water.Vetiver and canna species planted in horizontal flow constructed wetlands to achieve more removal efficiencies for BOD, COD and SS, less removal efficiency for turbidity, nitrates and phosphates.Compared to canna species, vetiver species is maximum removal efficiency for BOD and COD at 4 days retention time of 79.69 % and 76.58 % respectively. Test results are found that various parameters removal efficiency is reduced as the grey water passed through constructed wetland.Experiment was managed by different HRT of 2, 4 and 6 days. Several parameters show different removal efficiencies at different HRT. The characteristics of grey water from residential building depend on the life style, cultural and social activities of people and also source of water and consumption.

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