Experimental Analysis on Greywater Treatment System

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ABSTRACT

This study aims at treatment of greywater for irrigation and focusing on a treatment technology that is simple to operate, low cost with minimum maintenance. In this paper, we have compared and analyzed the efficiency of constructed wetland(CW) and drawer compacted sand filter treatment technology(DCSF). Constructed wetlands are one of the most promising treatment options for rural and suburban areas. In the constructed wetland, vertical flow and horizontal flow wetlands were planted with two different plants like reed and canna plant in a soil: sand: gravel composite medium. Drawer compacted sand filter treatment system, consists of 5 drawers in which 10 cm of sand media was placed in 3 drawers 10cm of gravel was placed in first drawer and the last drawer was filled with activated charcoal. The raw and treated greywater was collected periodically and tested for physio-chemical parameters such as turbidity, pH, COD, BOD, conductivity and nitrates were analyzed. This paper concludes that DCSF and CW are an efficient method of greywater treatment as compared to the conventional method, so these can be implemented on small scale at houses,schools, colleges,commercial buildings etc. This project also focuses on the combined irrigation systems such as aquaponics and hydroponics by the treated water.

INTRODUCTION

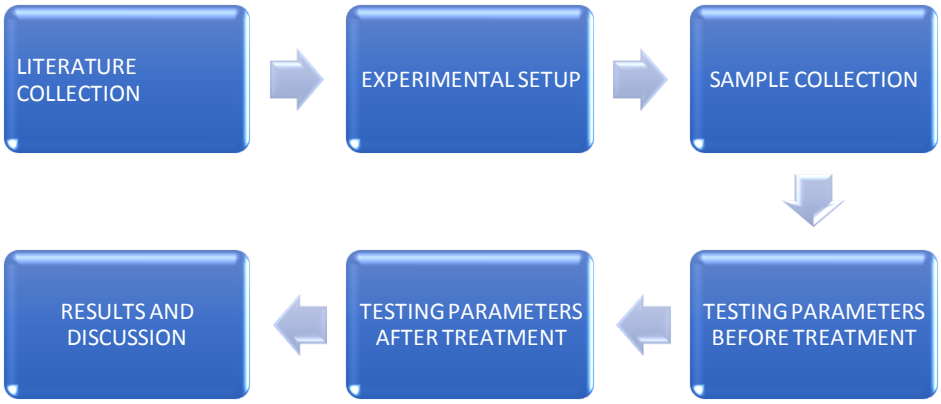
Water covers 70 percent of the globe's surface in which freshwater covers only 3 percent of it and much of the freshwater lies frozen in the Antarctica and Greenland polar ice. Water is becoming a rare resource in the world. It is therefore essential to reduce surface water use in all sectors of consumption, to substitute fresh water with alternative water resources and to optimize water use efficiency through reuse options. The alternative resource includes greywater. Greywater is the wastewater produced from sinks, baths and clothes-washing; it does not include toilet water, which contains bacteria and pathogens. Greywater represents 50-70% of total consumed water but contains only 30% of the organic fraction and 9-20% of the nutrients, thereby making it a good source for water reuse. Addition of greywater to surface water bodies can cause imbalance in pH levels, increase in oxygen demand and increase in turbidity. Greywater recycling is an ensuring step for proper and effective use of water. The population increase has increased not only the freshwater demand but also the volume of wastewater discharged. Domestic wastewater treatment and reuse is becoming an important field of research in global context of increasing water scarcity and inadequate sanitation. Usually simple treatment system adopted for the purpose of landscape irrigation are sand/gravel filter, settlement and floatation are operated to prevent clogging of the distributing system. Recently, greywater treatment has been studied either by application of high-rate aerobic systems, such as rotating biological contractor, flushing bed, aerobic filter, membrane bioreactor or by application of low-rate systems such as slow sand filter and vertical flow constructed wetlands.

This project will focus on greywater treatment and its use as an alternative water resource in the field of irrigation by two methods. The first method is a constructed wetland system that removes a significant amount of pollutants from a greywater. Constructed wetland is considered as one of the most eco- friendly and economical. Second method is intermittent sand filter has been used successfully in water and wastewater treatment for morthan a century. It is used to describe multi-layer series of bed filled with particular medium i.e., washed graded

sands, gravel and activated charcoal. The water percolates through the filter media by using well-designed manifold lines placed over the upper sand surface .However all scientific evidences have proved that treatment in sand filter is mainly aerobic i.e., biofilms develops on the sand particles which, in turns, absorb soluble organic matter as it percolates over the sand surface. Treated greywater can be used for many activities such as toilet flushing, garden watering and recreational irrigation.

METHODOLOGY:

The greywater was collected from our college boys hostel. The college is located in Madurai. The greywater which is generated from bathroom, and kitchen waste were collected. In kitchen wastewater containing oil and. grease which increases organic loading rate that's why we providing a sponge and woodchips in the inlet which is used to remove the oil and grease particles



MATERIALS AND METHODS:

CONSTRUCTED WETLANDS:

Constructed wetlands(CWs) are engineered systems that have been designed and constructed to utilize the natural processes involving wetland vegetation, soils, and the associated microbial assemblages to assist in treating waste waters. A Constructed wetland is an artificial wetland to treat municipal or industrial waste water, grey water, or storm water runoff. It may also be designed for land reclamation after mining, or as a mitigation step for natural areas lost to land development.

SELECTION OF PLANTS:

There are a few plants that are most recently used for grey water bio-filtration wetlands, many of which can be found in natural wetlands. Wetland plants found close to the constructed wetland area are the most beneficial because they are already accustomed to the local climatethe plants adopted here are:

- Canna (Typha spp.) are hardy easy to propagate and they remove large amounts of nitrates and phosphate.
- Reed grasses (Phragmitesaustralis) are tall plants with deep roots, enabling more oxygen to reach the root zone than the above two plants.

DRAWER COMPACTED SAND FILTER TREATMENT:

Drawer Compacted Sand Filter DCSF is a modified design for sand filter, in which sand layer is broken down into several layers (10 cm each) and placed in a movable drawer separated by 10 cm space each. This is a new and innovative method for onsite greywater treatment. Drawer compacted sand filter treatment system consists of six movable drawers arranged at equal vertical space between them. The space between drawers is to ensure aeration. The main principle involved in this process is aeration, with the help of that oxygen have been increased which is useful to destroy the microorganisms.

GREYWATER EXPERIMENTAL SETUP:

The experimental setup was in the backside of the boys hostel mess of our college in order to collect the samples easily.

The constructed wetland treatment system consists of one horizontal reed bed flow and two vertical reed bed flow were planted with two different plants like kalvalai and reed plant. A

horizontal flow reed bed consists of rectangular tray of size 60x40x30 cm were filled with sand:soil:compost medium. A vertical flow reed bed consists of circular tank of diameter 10 cm with the depth of 12 cm. The red soil was filled with 1.8 cm ,coarse aggregate (3/4) inches were filled with 1.8 cm, fine aggregate was filled with 4.2 cm, coarse aggregate (1/4) inches were filled with 3 can. An inlet tank is provided before each horizontal flow in order to ensure the flow rate.

Figure: constructed wetland setup

Drawer Compacted Sand Filter DCSF is a modified design for sand filter, in which sand layer is broken down into several layers (10 cm each) and placed in a movable drawer separated by 10 cm space each.A steel frame work was fabricated in our college prototype. This steel framework stands which is used to hold the drawers. Drawer compacted sand filter treatment system consists of six movable drawers arranged at equal vertical space between them. The space between drawers is to ensure aeration. The total height of the drawer is 117cm.The dimensions of each drawer used is 50x30x10 cm. Each drawer was perforated with 15 holes of diameter 4mm through which water could penetrate easily. In addition, a cloth is spread over each drawer to inhibit sand percolation. Above all the five drawers, there is an additional drawer at the top, to which greywater is

supplied. Treated water was collected at the outlet tank.

SAMPLING AND TESTING:

For weekly twice, greywater sample was collected from the outlet of each treatment system and the characteristics of the raw and treated greywater was tested. The test conducted on the samples were chemical oxygen demand(COD),total dissolved solids(TDS),dissolved oxygen(DO),pH,turbidity,hardness,conductivity, biological oxygen demand(BOD).

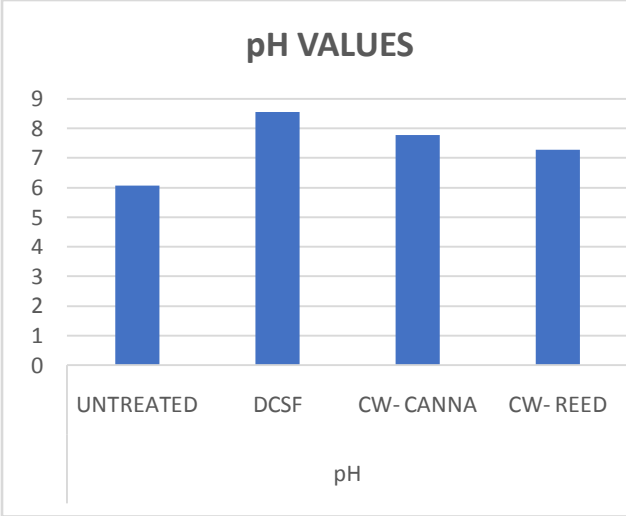
a. concentration of various parameters before and after treatment:

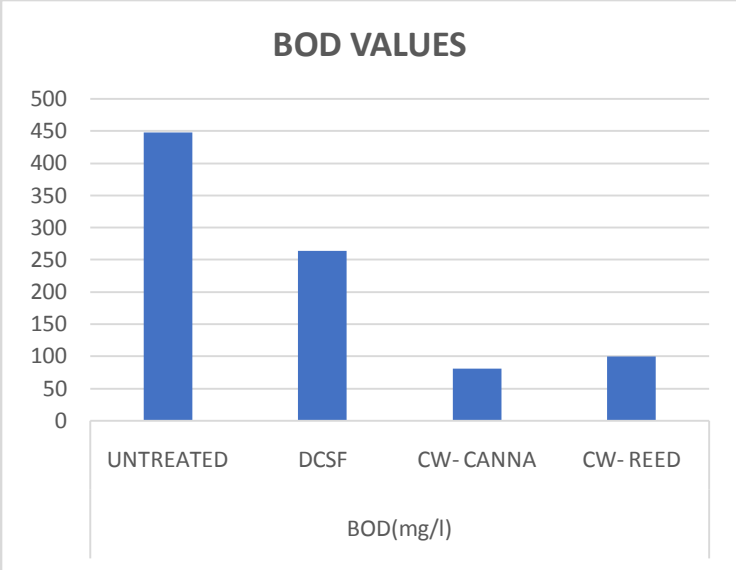
The characteristics of various parameters was tested for the collected sample and the values so obtained are tabulated in Table 1.

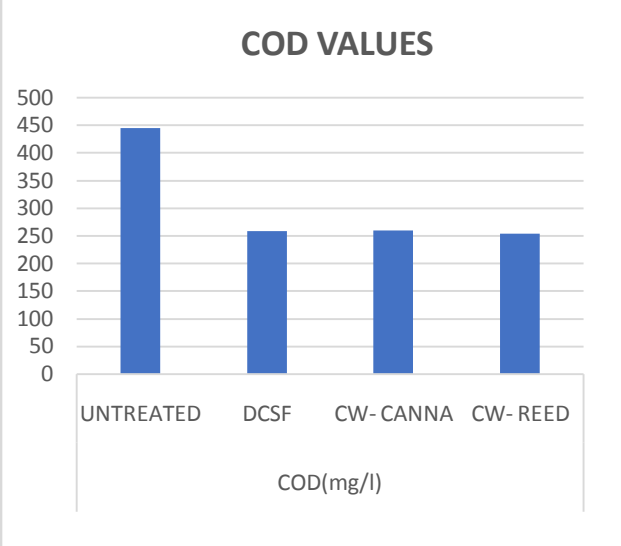
PARAMETERS	TREATMENT SYSTEM	SAMPLE					AVERAGE
		1	2	3	4	5	

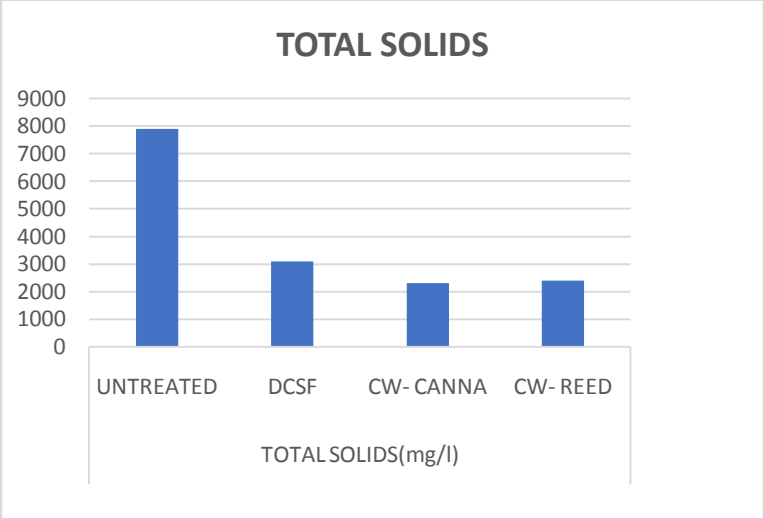
Ph	UNTREATED	6.06	6.10	6.04	6.15	6.14	6.09
	DCSF	8.9	8.75	8.54	8.6	8.10	8.57
	CW- CANNA	7.89	7.84	7.82	7.69	7.75	7.79
	CW- REED	7.49	7.34	7.10	7.25	7.30	7.29
BOD (mg/l)	UNTREATED	420	450	510.2	390.5	468.5	447.75
	DCSF	217	265.9	300.0	295.2	243.6	264.34
	CW- CANNA	75	71	106	64	88	80.8
	CW- REED	98.62	82.6	139	73.8	102.3	99.184
COD (mg/l)	UNTREATED	469.3	473.06	460.6	398.2	428.9	446.012
	DCSF	320.42	292.25	274.03	212.62	225.5	259.2
	CW- CANNA	331.02	281.5	245.12	218.3	226.01	260.2
	CW- REED	326.04	283	237.6	216.5	211.48	254.6
HARDNESS (mg/l)	UNTREATED	497.1	537.5	542.3	498.21	505.36	516.09
	DCSF	320.1	380.5	350.2	334.15	360.25	349.04
	CW- CANNA	242.0	230.1	221.2	210.5	231.6	227.08
	CW- REED	265.2	282.5	292.5	305.2	285.01	289.28
TOTAL SOLIDS (mg/l)	UNTREATED	8000	9000	7000	8000	7500	7900
	DCSF	3000	3500	3000	3000	3000	3100
	CW- CANNA	2500	3000	2000	2000	2000	2300
	CW- REED	2000	3000	2000	3000	2000	2400
CONDUCTIVITY (ms)	UNTREATED	7.28	8.44	7.16	7.84	7.16	7.57
	DCSF	4.64	5.40	4.28	5.24	4.41	4.79
	CW- CANNA	3.38	3.96	3.26	3.63	3.64	3.574
	CW- REED	3.66	3.84	3.48	3.74	3.52	3.648

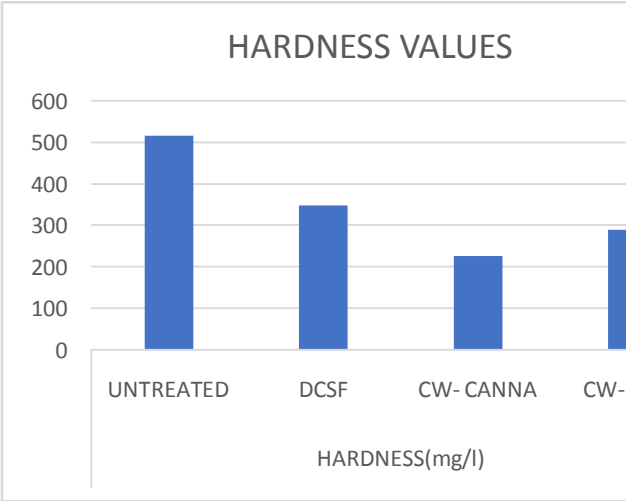
b. graphical representation of various parameter

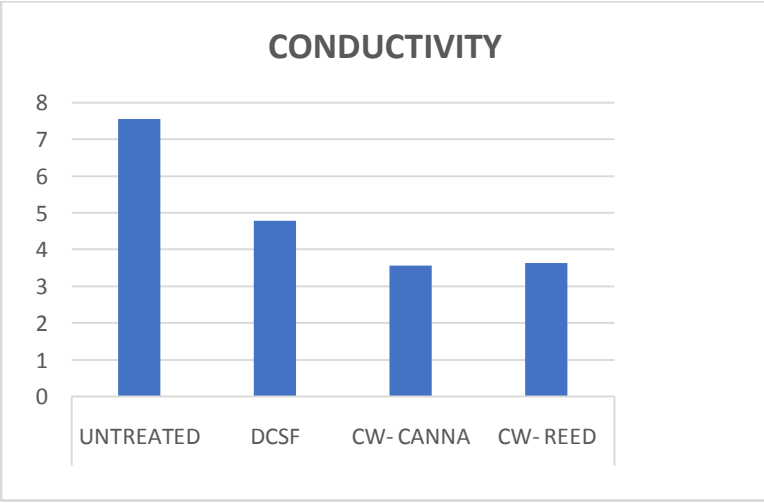












RESULTS AND DISCUSSION:

The results show that the concentration of six parameters for greywater treatment by the three treatment systems. It is clear that there is remarkable reduction in pH, BOD, COD, hardness, total solids, conductivity and the values of all the parameters are within the limits recommended for irrigation. The average percentage reduction in all parameters are 60-70%. During the starting stage the CW system has quite low efficiency in BOD and COD due to minimum growth of plant. In the later stage the root zone bed showed greater efficiency and the efficiency can be improved by using aerators to increase the oxygen supply. The DCSF could be designed in a smaller size than the current design guidelines with minimal maintenance requirements without sacrificing treatment performance and the infiltrative media in a movable drawer, distributes the organic and hydraulic load of waste water between the drawers. Finally, we have concluded thatthe constructed wetland (canna plant) has higher efficiency in the removal of BOD, total solids, hardness and conductivity. These treatment systems are cost effective and easily operated manually. This treatment system can also be used in small scale basis like houses, hotels, office etc.

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