DESIGN OF CONSTRUCTED WETLANDS FOR THE TREATMENT OF DOMESTIC WASTE WATER

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Abstract :Water is one of the most important elements involved in the creation and development of healthy life. Disposal of untreated wastewater from households as well as institutions & industry is causing deterioration of water bodies in urban areas in the developing world. A high level of responsibility towards water usage is required, & it must be recycled according to its pollution content in order to maintain water quality and protect our environment.

One of the methods of the treatment is constructed wetland. Constructed wetland system for wastewater treatment has been proven to be effective & sustainable alternative for conventional wastewater treatment technologies. The removal of pollutants in this system relies on a combination of physical, chemical and biological processes that naturally occur in wetland & are associated with vegetation, and their microbial communities. The present study undertaken by fabricating the lab scale model of constructed wetland.

The effluent of GM Institute of technology is treated with this system and wastewater characteristic like pH, DO, TURBIDITY, BOD, COD with & without plant species studied.

***Index Terms*–Constructed wetlands ,pH, DO, TURBIDITY, BOD, COD.**

I. INTRODUCTION

Constructed wetlands systems for wastewater treatment technologies were proven effective, low cost and sustainable. The removal of pollutants in these systems relies on the combination of physical, chemical and biological process. The constructed wetlands were designed and constructed that utilized natural processes for treating wastewater. Plants, soils and microorganisms were used to remove contaminants from wastewater. Constructed wetlands have been used internationally that gave good result.

Constructed wetlands contained four major components:

1. Vegetation
2. Substrate
3. Water column
4. Living organisms

Constructed wetlands were generally classified into subsurface flow and free water surface systems,

1. Surface Flow Constructed wetlands (SFCW)
2. Subsurface Flow Constructed wetlands (SSFCW)
   i. Vertical flow constructed wetland
   ii. Horizontal subsurface flow constructed wetland

II. LITERATURE REVIEW

Mr. Suhail N. Abed, et.al., (2018) showed that the worldwide water shortage challenge showing that around half of the total populace is probably going to encounter water worried by 2030 and an expansion in the worldwide water request was evaluated to be 55% by 2050. Having investigated wastewater recovery utilizing wetland innovation, the accompanying has been closed. Pollution is expelled through the procedure, which is normal in wetlands, while in built wetlands, these procedures are attempted under increasingly controlled conditions. All sorts of built wetlands are successful in expelling natural and suspended solids, while expulsion of nitrogen is lower, yet could be improved by utilizing a mix of different kinds of developed wetlands. •Removal of phosphorous is normally low, except if exceptional media with high sorption limit are utilized Successful pathogen removal from constructed wetlands effluent was challenging. Storage of the wetlands effluent in lagoons proved beneficial for pathogen removal. In addition to treatment, constructed wetlands are often designed as dual or multiple purpose ecosystems, which may provide other ecosystem services such as flood control, carbon sequestration or wildlife habitat.

M.Bisri, Donny Harisuseno etal.,(2018) showed that Blackwater is a type of domestic wastewater that must be processed before discharge into the river. This study uses gravel, sand, and charcoal as filtration materials. Charcoal can also be used in water filter due to its activated carbon content. Charcoal is a convenient filter material for water treatment since it can reduce various chemical and physical pollutants, and also cheap and easy to get. The results showed that filters can reduce the levels of BOD and COD effectively.

Michael O and Alatise (2019), this study was carried out to evaluate the performance of a charcoal-based constructed wetland (CBCW) in treating wastewater. CWs principle is a highly effective and ecologically sound design that makes use of plants, microbes, sunlight, and gravity to recycle and purify wastewater into reusable water. In evaluating the performance efficiency of the treatment system, the result showed the removal efficiency of 100, 93, and 88% for nitrate, BOD5, and COD, respectively. Due to the efficiency and effectiveness of CWs in removing contaminants in wastewater, it can be recommended for use, especially in developing countries for the treatment of any type of wastewater because of its low cost technology.

III. OBJECTIVES

The following are the objectives of the present experimental work:

1. Characterization of domestic waste wastewater.
2. Design and fabrication of the constructed wetland unit
3. The optimize variables like flow rate filter media and duration.
4. To check the removal efficiency of various parameters like BOD, COD, pH, turbidity, etc.
5. To check the suitability of treated water for the irrigation.

IV. MATERIALS AND METHODOLGY

4.1 MATERIALS

Coarse aggregate: They are gravel and crushed stones predominantly retained on the 4.75mm sieve. Size of aggregates used: 20mm to 40mm.

Fine aggregate: They are sand or crushed stones and completely passing through the 9.5mm sieve. Fine aggregate used: River sand

Stainless steel wire mesh: It is a versatile item that have many different customer use for many different application and made up of stainless steel. Wire mesh was used as a separator between the filter layers Sieve openings in mesh: 4.76mm

Fiber tap: Fiber tap is made up of hard reinforced plastic material. Size of tap: half inch diameter was used

Container: The container is made up of acrylic sheet. Acrylic sheet refers to the family of synthetic or manmade plastic materials containing one are more derivatives of acrylic acid. It is tough, highly transparent and it can be cut, drilled and formed

Inlet pipe and valve: Pipe is used to inlet the waste water to the constructed wetland and valve is provided to control the flow of the waste water. Diameter of outlet valve used was 6mm.

Plants used in wetlands: Giant Reeds (Arundo donax) and Dwarf Bullrush (Typha minima).

Charcoal: Is additional layer with respect to other filtering layers . charcoals is one of the most efficient techniques used in water treatment process for the removal of organics and micro pollutants from wastes and drinking water.

4.2 METHODOLOGY

In vertical flow constructed wetlands without vegetation it comprises of three layers of filter media. They are fine aggregate, coarse aggregate and fine aggregates respective to the top, middle and bottom layers of the filter media. All the three layers are separated by the stainless steel wire mesh. The waste water which was collected was supplied to the tank container tank using a pipe. The water flowed at a constant flow rate of .25m3 /day by the action of gravity through the filter layers slowly for a detention time of 6hrs. The wastewater passing the filter media was collected through the tap and was analyzed for different parameters.

Fig 4.2 Design of vertical flow constructed wetlands

In horizontal flow constructed wetland with vegetation comprised of giant reeds and dwarf bulrush is constructed with three layers of filter media. They are fine aggregate, coarse aggregate and fine aggregates respective to the top, middle and bottom layers of the filter media. All the three layers are separated by the stainless steel wire mesh. The waste water which was collected was supplied to the tank container tank using a pipe. The water flowed at a constant flow rate of .25m3 /day by the action of gravity through the filter layers slowly for a detention time of 6hrs. The wastewater passing the filter media was collected through the tap and was analyzed for different parameters.

In the charcoal based constructed wetlands with vegetation is constituted with the use of charcoal in it. It is also having a three layers of filter media. They are fine aggregate, coarse aggregate and fine aggregates respective to the top, middle and bottom layers of the filter media. All the three layers are separated by the stainless steel wire mesh. The waste water which was collected was supplied to the tank container tank using a pipe. The water flowed at a constant flow rate of .25m3 /day by the action of gravity through the filter layers slowly for a detention time of 6hrs. The wastewater passing the filter media was collected through the tap and was analyzed for different parameters.

Fig 4.3 Design of horizontal flow constructed wetlands

Fig 4.4 Charcoal used in constructed wetlands

The samples were collected and were tested for the parameters such as pH, Dissolved oxygen(DO), Turbidity, Biological oxygen demand(BOD) and Chemical oxygen demand(COD) as per the standard.

V. EXPERIMENTAL RESULT

5.1 pH

Table No 5.1: pH values for alternative day

Time in days	HFCW	VFCW	CBCW
1	8.1	8.6	8.4
3	11.8	11.4	13.4
5	7.7	7.8	8.2

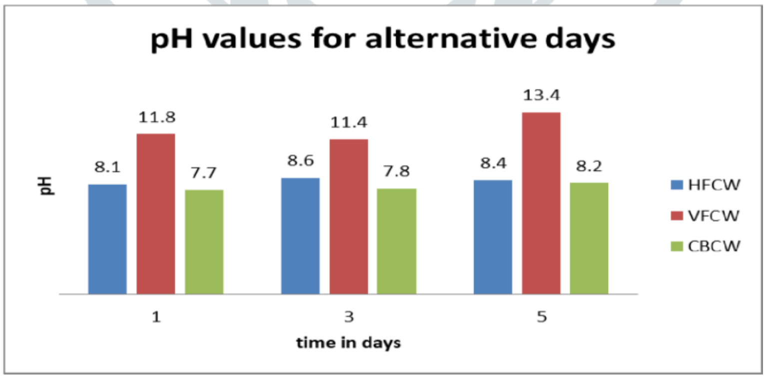

Figure No 5.1: Graphical representation pH values for alternative day

5.2 TURBIDITY

Table No 5.2: Turbidity values for alternative days

Time in days	HFCW	VFCW	CBCW
1	75.42	84.72	93.89
3	51.04	68.72	84.56
5	58.3	79.2	85.4

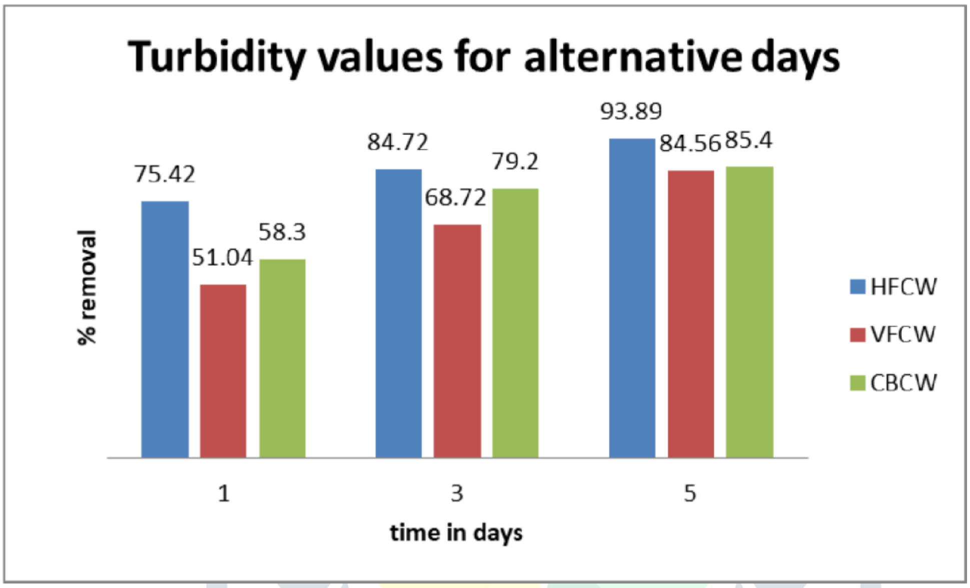

Figure No 5.2: Graphical representation of turbidity values after treatment

5.3 DISSOLVED OXYGEN

Table No 5.3: DO values for alternative days

Time in days	HFCW	VFCW	CBCW
1	59.42	45.38	55.67
3	48.83	40.38	30.64
5	31.77	22.8	36.04

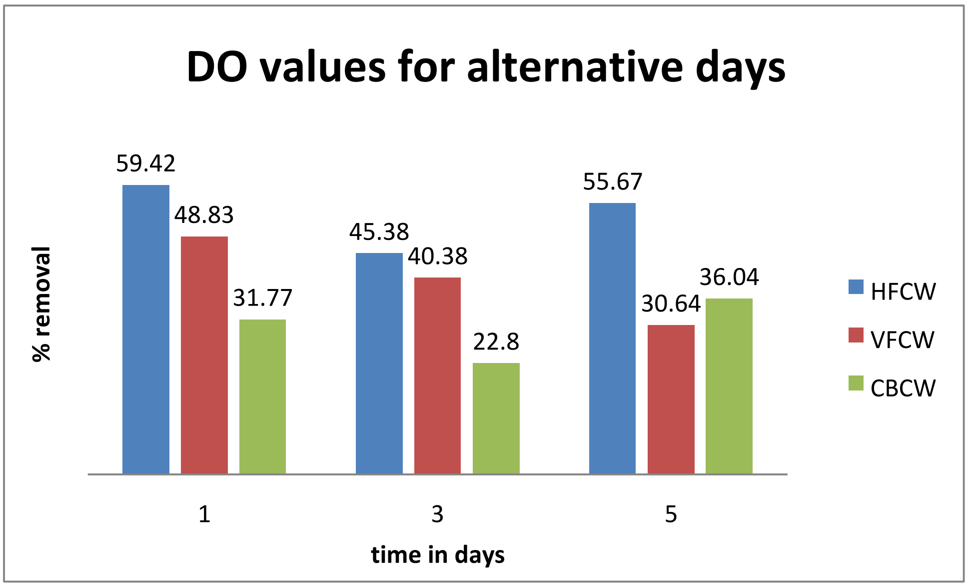

Figure No 5.3: Graphical representation of DO values after treatment

5.4 BIOLOGICAL OXYGEN DEMAND

Table No 5.4: BOD values for alternative days

Time in days	HFCW	VFCW	CBCW
1	59.24	75.77	83.78
3	32.3	39.73	39.06
5	30.57	72.21	92.56

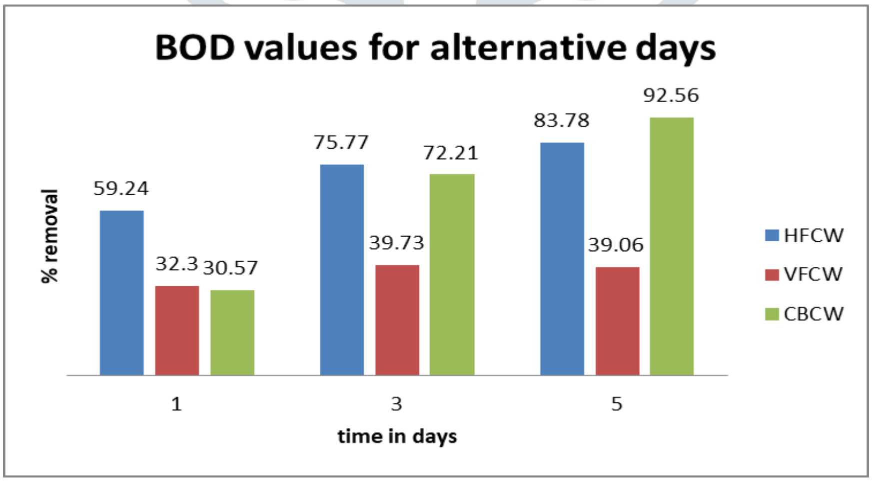

Figure No 5.4: Graphical representation of BOD values after treatment

5.5 CHEMICAL OXYGEN DEMAND

Table No 5.5: COD values for alternative days

Time in days	HFCW	VFCW	CBCW
1	59.24	75.55	18.13
3	32.3	39.73	47.12
5	18.13	39.06	73.91

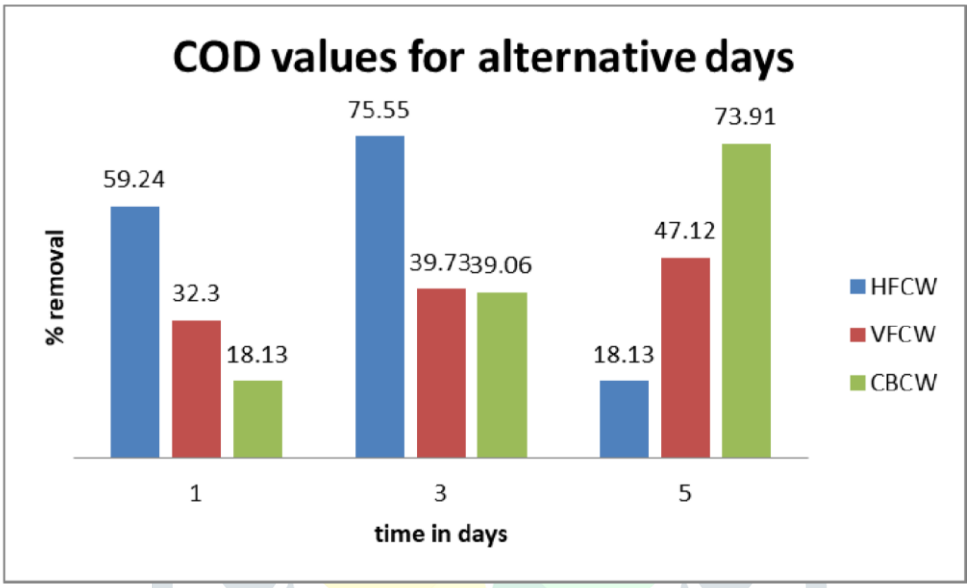

Figure No 5.5: Graphical representation of COD values after treatment

VI.OBSERVATION AND DISCUSSION

The above given parameters were analyzed for all the three types of constructed wetlands. The test was conducted for both pre and post characteristics of the water in the process of treatment of water for detention time of five days. The percentage removal of all the three constructed wetlands are discussed as follows.

pH: For five days detention time vertical flow constructed wetland showed 30.12 % removal, horizontal flow constructed wetland showed 7.91 % and charcoal based showed 6.8 %. The increase in the pH was due to the presence of aggregates. They neutralize wastewater by increasing the pH level.

Turbidity: For five days detention time vertical flow constructed wetland showed 69.09% removal, horizontal flow constructed wetland showed 85.1% and % and charcoal based showed 74.3 %. The removal mechanism of water turbidity in the wetlands is due to sedimentation and filtration facilitated by plant roots that reduces interspaces between gravel by forming dense filter media that removes suspended particles. However, both horizontal and charcoal based constructed wetlands showed better efficiency.

Dissolved oxygen: For five days detention time vertical flow constructed wetland showed 41.54 % removal, horizontal flow constructed wetland showed 18.62 % and charcoal based showed 4.17 %. The % removal efficiency of HFCW was found 18.62% more than VFCW due to the use of carbon dioxide by the plants that were used for the photosynthesis process and due to the presence of microbial organisms and bacteria.

Biological oxygen demand: The characteristics of the raw wastewater in the inlet and the characteristics of treated wastewater at the outlet were studied for the detention time of 5 days. For five days detention time vertical flow constructed wetland showed 37.24 % removal, horizontal flow constructed wetland showed 73.49 % and charcoal based showed 65.11 %.

Chemical oxygen demand: The characteristics of the raw wastewater in the inlet and the characteristics of treated wastewater at the outlet were studied for the detention time of 5 days. For five days detention time vertical flow constructed wetland showed 58.31 % removal, , horizontal flow constructed wetland showed 69.30 % and charcoal based showed 46.38 % efficiency. The BOD and COD removal efficiency is not affected bed dimensions it was fine and coarse aggregates that affected the removal efficiency, i.e. it was due to filtration, sedimentation.

VII.CONCLUSIONS

1. Constructed treatment wetlands have developed during the most recent five decades into a solid treatment innovation which can be applied to a wide range of wastewater including sewage, mechanical and agrarian wastewaters, landfill leachate and storm water spillover.
2. Constructed wetlands require extremely low or zero vitality input and, in this manner, the activity and support costs are a lot of lower contrasted with regular treatment Frameworks.
3. Both VFCW and HFCW considerably decreased the boundaries like pH, turbidity, DO, BOD5 and COD to a sensible degree for local waste water.
4. The absolute treatment process is affected by the vegetation, sand layers and substrate association.
5. The HFCW indicated better evacuation proficiency when contrasted and VFCW.
6. The CBCW demonstrated proficient in rewarding the household squander water yet the evacuation effectiveness was discovered higher again in HFCW.

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