Customized Constructed Wetland – An Experimental Study over Specially Modified Constructed Wetland

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Abstract— Severe damage to water bodies is caused due to the untreated wastewater from industries, institutions and households. Hence, there is a need of effective wastewater treatment technologies for the sustainable development. To treat the medium strength domestic wastewater, an Experimental laboratory scale model of constructed wetland was developed. Experimental Lab scale model having inlet and outlet arrangement was fabricated using thick GI sheet of thickness 0.55 mm. It was proposed to provide the treatment of medium strength domestic wastewater by using the experimental lab scale model having four numbers of compartments. The overall capacity of the experimental lab scale model was 60 L. The Inlet and outlet arrangement were provided at both ends of the model. The reactor was operated as continuous flow reactor with varying detention time and different types of media such as Natural and Artificial. The performance of customized constructed wetland reactor was observed for nearly 5 months under various operating conditions for Biochemical Oxygen Demand, Total Solids and Chemical Oxygen Demand parameters. The Experimental Lab scale Model of Customized Constructed Wetland claims removal efficiencies such as 74.11% for Total Solids, 73.92% for Biochemical Oxygen Demand, and 72.17% of Chemical Oxygen Demand. The present paper discusses various aspects associated with Customized Constructed Wetland system. The detailed information about the development and working of the model are also described in detail. The observed data during the study is presented in tabular format.

Key words: Constructed Wetland, Biochemical Oxygen Demand, Experimental Lab scale Model

I. INTRODUCTION

Wetland utilization generates economic savings because they depends on more natural methods, they are less expensive to construct and operate than conventional sewage treatment (e.g., low electricity consumption); furthermore the purified water is suitable for reuse and recycle. Purified water for reuse is a very valuable asset as drinking water is a scarce resource that is fundamental to human existence.

Wetlands are among the most important ecosystems on the earth because of their ability to cleanse polluted waters, prevent floods and storm surges, protect shorelines, bring about sediment control and nutrient recycling and recharge groundwater aquifers. Despite of the high biodiversity and the high importance of the goods and services of wetland ecosystems, local and regional wetlands are under increased threat by human activities. The functional role of wetlands in improving water quality has been a compelling argument for the preservation of natural wetlands and the construction of wetland systems for wastewater treatment. Constructed wetlands are systems of artificial wastewater treatment consisting of shallow (generally less than 1 m deep) ponds or channels that have been planted with aquatic plants, which are based on the natural microbial, biological, physical and chemical treatment of wastewater. Typically constructed wetlands have impermeable clay or synthetic coatings and artificial structures for controlling the direction of flow, liquid retention time and the water level. Depending on the type of system, they may or may not contain an inert porous media such as rock, gravel or sand. Constructed wetlands have been used to treat a variety of wastewater, including urban run-off, municipal, industrial, agricultural and acid mine drainage. While some degree of prior or subsequent treatment in conjunction with the wetlands to treat wastewater is required to meet discharge requirements stream or reuse, the wetland will be the central component of treatment. Wetlands have been used to provide tertiary treatment of urban waste water as an alternative to conventional methods.

II. AIMS & OBJECTIVES

Considering the requirements of domestic treatment system to be economical and simple in operation, the present study is under taken with following objectives is as follows:

1) To evaluate the feasibility & efficiency of Customized constructed wetland.
2) To study the effects of different Media such as Natural and Artificial Media.
3) To study effect of Customized Constructed wetland operation on contaminant removal
4) To study the selected parameters *e.g.* BOD, COD and TS for treated effluent.
5) To study the effects of different media on effluent quality.

III. EXPERIMENTAL MODEL & METHODOLOGY

The laboratory scale model of having inlet and outlet arrangement was fabricated using thick Galvanized Iron sheet. It is proposed to provide the treatment of domestic wastewater by using the experimental lab scale model having four compartments. The overall capacity of the model was 60 liters .The Inlet and outlet arrangement were

provided at both ends. The reactor was operated as continuous flow reactor with varying detention time & different types of media. The performance of customized constructed wetland reactor was observed for nearly 5 months under various operating conditions for Biochemical Oxygen Demand, Total Solids and Chemical Oxygen Demand parameters. As compared to the conventional constructed wetland, this model eliminates the short-circuiting of the wastewater through the length of wetland & hence the influent gets maximum degree of the treatment within this customized constructed wetland model.

IV. MATERIALS

The Study includes mainly four materials such as Aerocon blocks, Snail Shells and Crushed sand as shown in Fig.1. The model setup was consisting of four compartments with the provision of one extra inlet chamber. All the Compartments consist of one stationary baffle (2 inches above from bottom portion) so as to divide it into two compartments having independent compartments volume 5 liters.

Fig. 1: Media/Materials used in Customized Constructed Wetland

All the compartments packed with the same media configuration such as the bottom most layer of 45-60 mm was Aerocone blocks up to 8 cm, followed by 37.5-45 mm Aerocon blocks up to 8 cm, followed by Aerocon stones of 25-37.5 mm up to 8 cm, followed by snail shells up to 6 cm, followed by crushed snail shells up to 6 cm, followed by crushed Aerocone Blocks up to 6 cm was filled successively from bottom to top (Fig. 2).

Fig. 2: Arrangement of Different Size of Media

V. WORKING OF MODEL

The whole reactor unit was fed with domestic wastewater at designed inflow. The detention time was kept variable such as 12, 15, 18, 21, 24, and 27 Hours. According to the detention time, the model was started to work. Wetland plants such as Typha Green Bulrush Plants were used throughout the length of the Customized constructed wetland. From the inlet chamber, wastewater entered in the 1st compartment. The provision of baffle was made for down flow and up flow of wastewater over the media which placed in first compartment. Through the inlet chamber, wastewater dripped down over the Aerocone blocks placed in the five layers with different configuration of media sizes in compartment one with two compartments. Wastewater in the media got percolated to the bottom of compartment with alternate flow regime. In the second compartment, the alternate down flow and up flow regime of wastewater was maintained in the next third compartment with the help of baffles (Table 1).

Compartment	**Compartment Configuration**	**Flow Regime**
No.1	No.1 Provided with one stationary baffle No.2	Down to Up
No.2	No.3 Provided with one stationary baffle No.3	Down to Up
No.3	No.5 Provided with one stationary baffle No.6	Down to Up
No.4	No.7 Horizontal Wetland	Down

Table 1: Flow Regime of Compartments

The wastewater that released from the compartment no.6 of the third compartment entered in the last compartment from the top. The final treatment of wastewater was carried out in the horizontal constructed wetland reactor. The wetland grass/plants comes in a contact with the wastewater, the Nutrients such as Nitrogen & Phosphorus present in wastewater gets removed. This facilitated the biological wastewater treatment. Then this treated effluent water was discharged in the collection tank through the outlet provided.

VI. RESULTS & DISCUSSION

This study gives an overview performance of various designs and functioning characteristics of customized constructed wetland. The performance of reactor packed with coarse to fine media configuration along with the Green Bulrush Typha plants in all compartments showed better performance as compared to conventional constructed wetland for domestic wastewater treatment and it was

claimed that remarkable increase in removal efficiencies as high as 74.11% for Total Solids, 73.92% for Biochemical Oxygen Demand, and 72.17% of Chemical Oxygen Demand for 24 hours of detention time (Table 2). Graphical Representation of Removal Efficiencies is shown in (Graph 1).

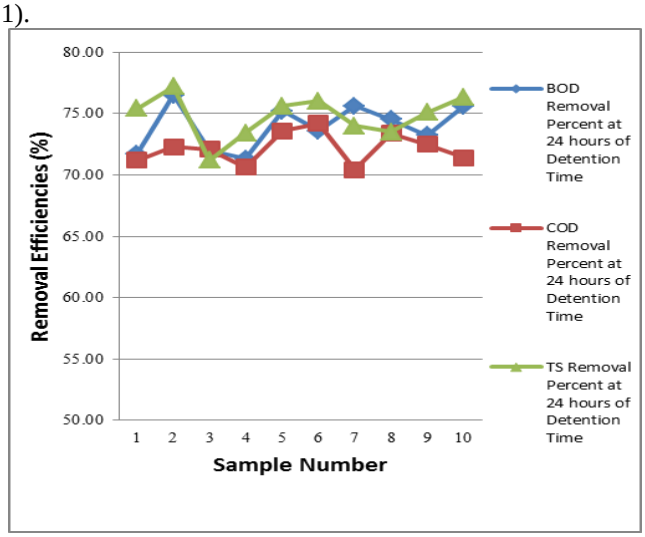

Fig. 3: Graph 1 Graphical Representation of Removal Efficiencies

Sample No.	Raw Sewage			Treated Sewage			Percent Removal		
	BOD	COD	TS	BOD	COD	TS	BOD	COD	TS
1	214	356	255	61	103	63	71.70	71.20	75.40
2	178	254	236	42	70	54	76.50	72.30	77.20
3	208	260	274	58	73	79	72.00	72.10	71.20
4	234	396	313	67	116	83	71.30	70.60	73.40
5	188	470	217	47	124	53	75.20	73.60	75.60
6	241	395	361	64	102	87	73.60	74.20	76.00
7	219	353	347	53	104	90	75.60	70.40	74.00
8	238	396	281	61	105	74	74.50	73.40	73.50
9	215	364	276	58	100	69	73.20	72.50	75.10
10	227	391	323	55	112	76	75.60	71.40	76.34

Table 2: Performance of the Customized Constructed Wetland Model at 24 Hours of Detention Time

VII. Conclusions

Parameters such as BOD, COD and TS of wastewater were analyzed. Standard methods were used for calculating the parameters. The raw wastewater collected from the local Nallah flowing through Kathora Naka area (Amravati, Maharashtra) and its characteristics were studied. Different parameters were analyzed for varying conditions like different detention time.

With the increase in detention period there was considerable increase in the performance of combination of compartments followed by the increase in removal rate. With careful design and planning, customized constructed wetland with effective attached growth can remove variety of contaminants. It was found that the study proves to be economical and efficient for treatment of domestic wastewater. Customized Constructed Wetland as compared to conventional constructed wetland eliminates the short-circuiting of wastewater through the length of wetland.

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