International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON WASTEWATER BY REED BED TECHNOLOGY USING ORNAMENTAL PLANTS

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Abstract – *Due to high intake of water, there is high generation of wastewater in these days. In rural areas, using conventional method is not suitable for treating this large amount of wastewater as they are highly expensive. Constructed wetlands or Reed bed technology is natural method using plants which are proven to be cost effective and sustainable. In this project a study is conducted to find effectiveness of plant species (Canna indica and Heliconia psittacorum) in horizontal subsurface flow constructed wetlands and reed less bed for removing pollutant from domestic wastewater. Various physiochemical parameters are analyzed like pH, Conductivity, DO,BOD,COD,TSS,TDS and chloride with 1, 3 ,6 days HRT. Result shows more reduction of parameters in constructed wetlands unit having Canna indica plant species with 6 day HRT than the other two units.*

***Key Words*: Constructed wetlands (CW), ornamental plants, domestic wastewater, Canna, Heliconia, reed bed**

1. INTRODUCTION

As the amount of wastewater generating in different processes is increasing day by day, treating wastewater is becoming important before the disposal. By treating this wastewater the effect of pollution in the environment will decrease. The conventional treatment methods are costly; they require skilled personals and power. Reed bed or constructed wetlands is one of the cheap natural methods used for treating domestic, agricultural liquid and industrial processing waste. Reed bed is a biological wastewater treatment technology. These systems use wetland plants, soils and associated microorganisms to remove contaminants and impurities from wastewater. These plants play an important role in treatment of waste water.[6] The contaminants present in the wastewater are treated as they seep through the root-zone of the plants by a combination of plants, soil, and bacteria and hydraulic flow systems resulting in physical, chemical, and microbiological processes. Oxygen present in the zones closer to the roots facilitates the degradation of wastewater. A wide variety of microorganisms present in the root-zone of the plants results in efficient degradation of organics. [2]

The vegetation used in the constructed wetlands (CWs) plays an important role in wastewater treatment. In recent studies (15 years ago), the goal of CW studies involved an investigation of the using the herbaceous perennial ornamental plants in CWs, including the using different colored flowers to make the systems more aesthetic, and which makes it more probable for adoption and replication. However, there are some physiological characteristics of ornamental flowering plants that are similar to the plants of natural wetlands that have capacity of pollutants removal in waste water treatments. A survey showed that the most commonly used flowering ornamental vegetation genera were Canna, Iris, Heliconia and Zantedeschia. Both flowering ornamental wetlands and natural wetlands show similar removal efficiency. However, removal efficiency was better in using ornamental plants than in unplanted CWs. [4]

1.1 Objective of study

(1) To investigate the feasibility of applying a constructed wetland system to treat the waste water.

(2) To compare the treatment efficiency of reed bed system with conventional treatment plant.

2. METHODOLOGY

2.1 Materials and Sample collection

In this project the experiment is carried out by using Indian shot of species Canna indica and false bird of paradise of species Heliconia psittacorum. The plant saplings are collected from local gardening nursery nearby Kannur. The domestic wastewater collected from different household activities is used in this experiment. Various materials used for the constructed wetlands were as follows:

1) Plastic container

2) Plastic buckets

3) PVC pipe

4) Taps

2.2 Experimental setup and Method

There are three zones in the experimental setup. They are inlet zone, constructed wetland units and outlet zones. In the inlet zone, there are buckets which hold the wastewater sample and flow controlled by taps. In the constructed wetland units, there is a plastic container having a 1% slope at bottom. This unit has three layers having gravel, sand and locally available red soil from bottom to top respectively. The third zone is outlet zone, having an outlet pipe for collecting the treated water. Figure 1 shows the experimental setup of the study.

Fig -1: Experimental setup

The experimental setup consists of a three units of constructed wetland systems. Two constructed wetlands systems with two different ornamental plants and one is without plant. The pilot scale model of horizontal subsurface flow constructed wetland has been built in Environmental laboratory at a site of KMCT College of Engineering For Women, Calicut. The experiment was carried out in three pilot scale units were fed with fresh water for a period of one month. The untreated wastewater were collected in these holding buckets and fed into these three wetland units. These samples are collected from this outlet pipes by using plastic bottles and analyzed for various parameters by varying the HRT of 1, 3, 6 days. Removal efficiencies of different parameters in different constructed wetlands units are studied.

3. RESULTS AND DISCUSSION

This section deals with the results and discussion showing promising results of treatment of wastewater by reed bed technology using ornamental flowering plants and a control reed bed.

Table -1: Characteristics of waste water before treatment

Parameters	Before treatment
pH	9.2
EC (µS/cm)	1446
DO (mg/l)	4.1
BOD (mg/l)	185
COD (mg/l)	560
TSS (mg/l)	286
TDS (ppm)	220
Chloride (mg/l)	123.2

3.1 Variation of parameters in constructed wetlands

Table 2 shows variation of parameters in different constructed wetlands units with 1, 3, 6 days HRT.

Table- 2: Variation of parameters with 1 day HRT

Parameters	After treatment		
	1st CW unit	2nd CW unit	Control bed
Ph	8.56	8.4	8.6
EC (µS/cm)	1112	1101	1232
DO (mg/l)	4.3	4.5	4.2
BOD (mg/l)	129	126	133
COD (mg/l)	408	401	439
TSS (mg/l)	145.85	143.2	149.23
TDS (ppm)	109	106	112
Chloride (mg/l)	103.1	101.8	109.25

Table 3 and Table 4 show the variation of parameters with 3 and 6 day HRT respectively. From the below tables it is clear that the first and second constructed wetland unit showed more reduction in various parameters than the control bed system. All parameters reduced more in second constructed wetland (with Canna indica) unit with 6 day HRT.

Table- 3: Variation of parameters with 3 day HRT

Parameters	After treatment		
	1st CW unit	2nd CW unit	Control bed
pH	8.45	8.23	8.56
EC (µS/cm)	998	986	1009
DO (mg/l)	4.4	4.6	4.3
BOD (mg/l)	88	83	92
COD (mg/l)	212	209	298
TSS (mg/l)	103.62	101.5	106.12
TDS (ppm)	85	83	93
Chloride (mg/l)	98.3	97.53	99.12

Table- 4: Variation of parameters with 6 day HRT

Parameters	After treatment		
	1st CW unit	2nd CW unit	Control bed
pH	8.26	8.12	8.37
EC (µS/cm)	797	786	805
DO (mg/l)	4.6	5	4.4
BOD (mg/l)	39	36	42
COD (mg/l)	64	62	69
TSS (mg/l)	43.12	39.05	43.12
TDS (ppm)	42	41	46
Chloride (mg/l)	96.43	95.02	98.5

3.2 Removal efficiency of treated wastewater

Table -5: Removal efficiency in different CW units

Parameters	Removal Efficiency (%)								
	Constructed wetland units								
	1 day HRT			3 day HRT			6 day HRT		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
BOD (mg/l)	30	32	28	53	55	48	79	81	77
COD (mg/l)	27	28	22	62	63	57	88	89	87
TSS (mg/l)	49	50	48	64	65	63	85	86	85
TDS (ppm)	51	52	49	62	63	58	81	81	79
Chloride (mg/l)	16	17	13	20	21	19	22	23	21

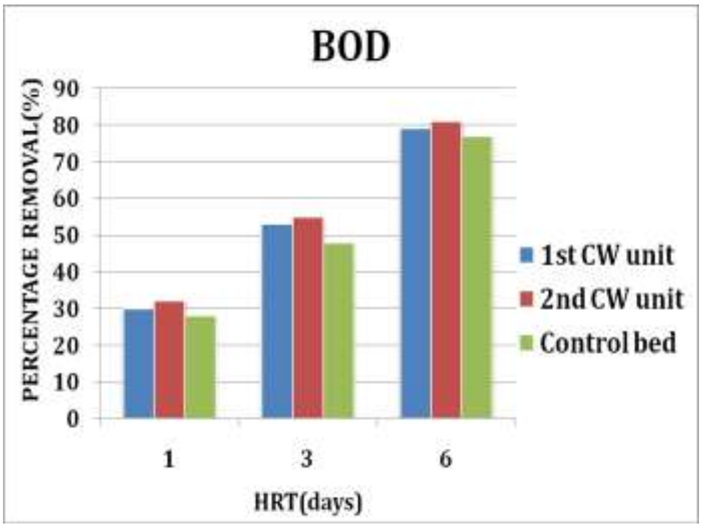

Chart -1: Removal efficiency of BOD in different CW unit in different HRT

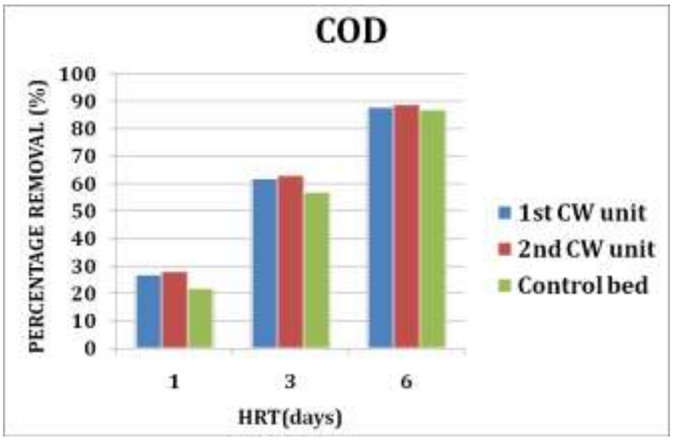

Chart -2: Removal efficiency of COD in different CW unit in different HRT

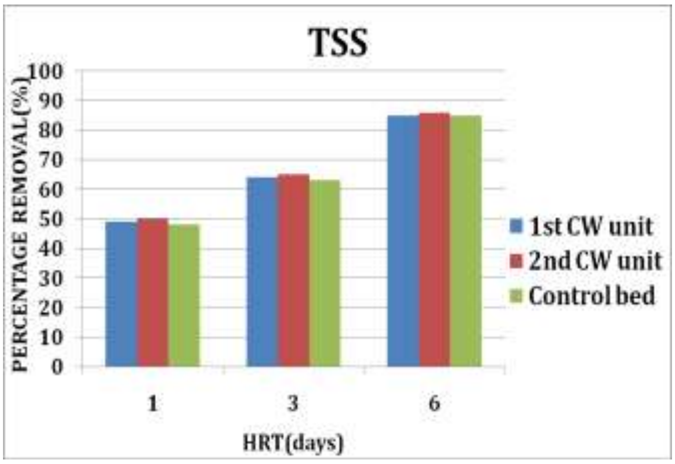

Chart -3: Removal efficiency of TSS in different CW unit in different HRT

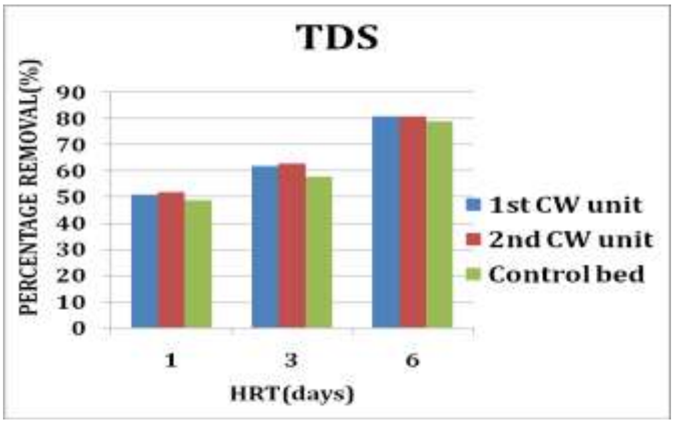

Chart -4: Removal efficiency of TDS in different CW unit in different HRT

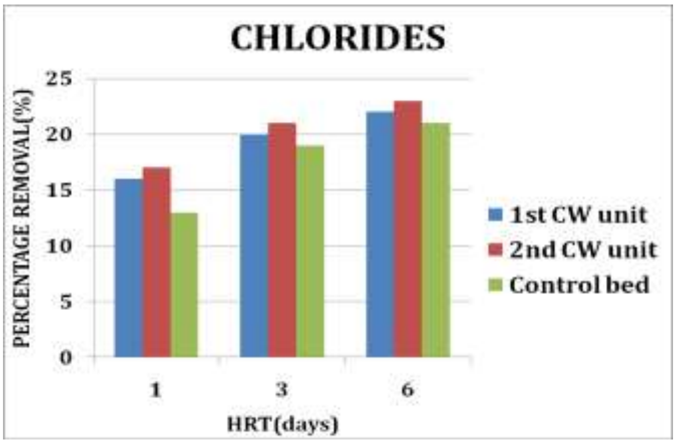

Chart -5: Removal efficiency of chloride in different CW unit in different HRT

From the above results and charts it is observed that the maximum removal efficiency of BOD content is observed in second CW unit having Canna indica. Percentage of removal increases with increasing HRT, so maximum removal is seen in 6 day HRT. After treatment, it was reduced by 79 %, 81%, 77% in first, second and control bed units respectively in 6 day HRT. This reduction is due the bacteria which are attached to the plant roots. Similar to BOD, the COD concentration is also reduced after the treatment. Maximum removal efficiency of COD content is observed in second CW unit having Canna indica in 6 day HRT. After treatment, it was reduced by 88 %, 89%, 87% in first, second and control bed units respectively in 6 day HRT. The TSS removal is found to be 85 %, 86%, 85% in first, second and control bed units respectively in 6 day HRT. The maximum removal efficiency of COD content is observed in second CW. Due to the mechanism of substrate media filtration, TSS is reduced.

After treatment, the percentage removal of TDS was 81 %, 81%, 79% in first, second and control bed units respectively in 6 day HRT. The chloride content is reduced more in second constructed wetland unit in 6 day HRT than the CW unit having heliconia and control bed having no plant. After the treatment, the percentage removal was 20%, 21%, 19% in first, second and control bed units respectively in 3 day HRT and it enhanced to 22%, 23%, 21% in first, second and control bed units respectively in 6 day HRT.

4. CONCLUSIONS

From the study conducted it is observed that after the treatment pollutants such as BOD, COD, TDS, TSS and chlorides were removed significantly from domestic and wastewater sample in the two reed beds. The pollutant removal efficiency of control bed is much less than the other two reed bed.

Canna indica removed pollutant more effectively than the Heliconia psittacorum. It is clear from the study that the maximum efficiency is achieved while increasing HRT. So the maximum removal efficiency is seen with 6 day HRT. In conclusion, use of these ornamental flowering plants is very efficient in cleaning the wastewater as it has many advantages like the production of flowers in the CWs, which will provide economic benefits to the operators and can improve the aesthetic appearance of the landscapes. Constructed wetland is an eco friendly and cost effective treatment method than the conventional treatment methods as there is no use of any special equipment or chemicals but only plants.

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