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Horizontal Flow Constructed Wetland for Treating the Sugar Industry Waste Waster

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ABSTRACT:The purpose of this study was to design of constructed wetlands for sugar industry waste 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 heliconia and yellow canna plants were selected. The root development of heliconia was deep and wide spread compared to yellow 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 heliconia in sand, 20mm gravel riverstones, 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 of7day, 14day, 21 day, 28day and 35days respectively. the removal efficiency achieved for23.9% of pH, 66.66% of D.O, 84.78 % of COD and 90.53% of BOD,81.48%of TDS, 58.365% of chlorides, and 47.06% of sulphate reduction for 35days HRT, of heliconia species, and 23.9% of pH, 66.66% of D.O, 83.47 % of COD and 86.66% of BOD,79.63%of TDS, 56.065% of chlorides, and 42.6% of sulphate reduction for 35days HRT, of yellow canna.

KEYWORDS:horizontal flow constructed wetland, retention time, sugar industry waste water, heliconia yellow canna.

I. INTRODUCTION

Constructed wetlands are artificial treatment methods for all type of industrial agricultural municipalities and other 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 (1).

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 chemical and biological changes takes place(2).

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 near to the treatment methods and design of the constructed wetland. The main focus on suitable vegetation selection in constructed wetland system depending 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.(3)

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 equipment's 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, granular media, wetland plants(4).

The Sugar industry plays an major role in the Indian budget as well as foreign currency earnings and also plays a very major role in polluting the ecosystem through its effluent disposal, water used for cleaning purposes in the different sections of the factory generates waste water(5).

the effluent from these industries is highly polluted. The sugar industry in India generates approximately 1000 litres of effluent per tonne of crushed sugar cane(6).

II. EXPERIMENTAL SET UP

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 heliconia which serves many purposes, removal of chlorides and sulphates and giving the oxygen at the root zones for putrefaction of organic matter, Figure1 shows Photographic View of Artificially Constructed Wetland Setup. Wastewater was fed into the system at regular intervals while the entire arrangement was on a roof. 15 days prior to the wastewater being fed into the cell, the wetland vegetation was planted there.By creating the wetland lake of the following measurements, a seat scale study was completed to determine the pollution boundaries and exhibit the built wetland. The wetland lake was constructed using 5mm thick acrylic sheets. The following describes the plan's boundaries: Length of the tank = 0.7m, Width of the tank = 0.3m, Depth of the tank = 0.45m.Total volume = Length× Breadth× Depth = 0.7m×0.3m×0.45m.TotalVolume=0.0945m3.Nearly 45% of volume, wastewater can be hold in the wetland cell.0.0945× 0.4 = 0.0378 m3 /day.Say 38 litres per day. Based on the wetland's architecture, a 38 litres per day flow rate was calculated theoretically. In order to determine the experimental flow rate, analysis was carried out by filling the entire wetland pond with media and determining the volume of water the pond can retain(7).

III. EXPERIMENTATION

To decide the exploratory stream rate, stream rate investigation was completed. The cycle incorporates Planned wet land lake is filled totally with squashed stone totals of 20 mm distance across the size. to determine the amount of water that fills the empty gaps and the maximum amount of water that a wetland lake can store at one 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(8).

The flow rate was determined experimentally to be 40 litres per day. Hence wastewater sample of 40 litres/day is required to be fed into the wetland pond for retention period of 1 day. As the retention time selected for work is 7 days wastewater required to be feed is 20 litres/day, for retention time of 14 days the wastewater to be fed is 10 litres/day, and for 21days 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 profunditychannel media, plant species, type of wastewater, method of activity lastly the pressure driven maintenance time(9).

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 7 days wastewater is fed into the system at each days start and the corresponding effluent for 7 days 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(10).

IV. OBESERVATIONS AND RESULTS

Initial characteristics of sugar industry effluents

The following table illustrates theInitial characteristics of effluents. Different tests were done to the effluent as per method given instandard procedure(11).

Table 1 initial characteristics of sugar industry

`Sl No	Parameter	Untreated Effluent
1	Colour	Dark brownish
2	pH	5.1
4	BOD	1500
5	COD	2350
6	TDS	2800

Reduction of pH at various retention periods

The pH of the effluent gradually increased during the incubation period as shown in Figure 2 and Table 2, clearly showing that both Heliconia and yellow Canna test plants can tolerate slightly acidic conditions and can grow in sugary wastewater.

Table2 Observed changes in effluent pH over the differentdetention periods

Sl no	Plants names	pH changes in initial waste water during the incubation period (days)					
		0	7	14	21	28	35
1	Heliconia	5.1	5.8	6	6.1	6.5	6.7
2	Yellow canna	5.1	5.3	5.9	6.4	6.8	6.9

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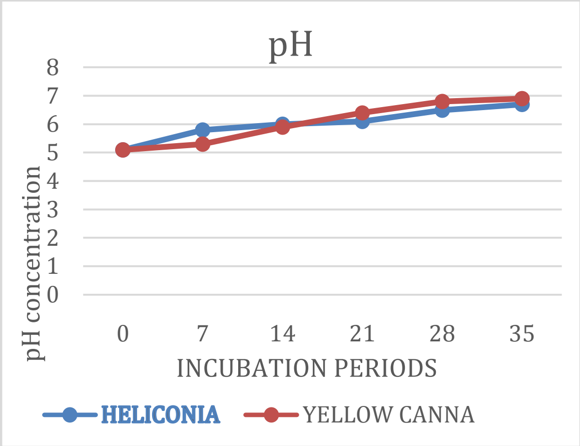

Figure 2 pH changes in Sugar industry waste-waste water during the incubation period with selected two plant.

Removal Efficiency Of BOD at different Retention Period.

Table 3 Performance of HFCW Taking Place In Removal Of BOD At Various Detention Times.

Sl No	Ditention time (Days)	Concentration Of BOD(Mg/L)	
		Heliconia	Yellow Canna
1	0	1500	1500
2	7	900	1100
3	14	720	628
4	21	650	545
5	28	320	480
6	35	200	142

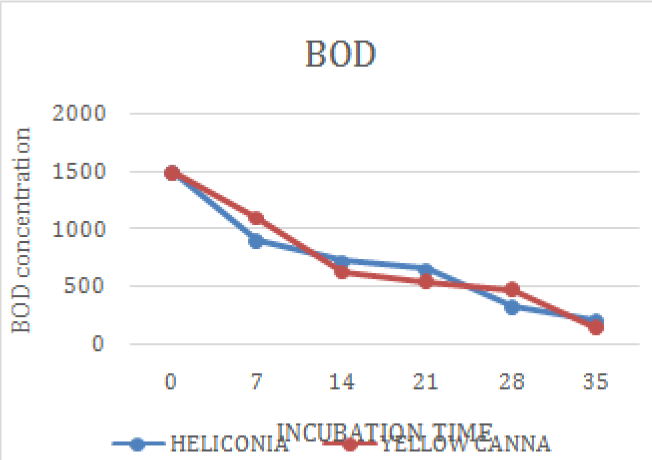

Figure 3 shows the variations in BOD of waste water from the sugar industry that were seen over the course of treatment at two distinct plant.

The Reduction of BOD in sugar industry wastewater was 26.66%, 58.13%, 63.66%, 68% and 90.53% at retentionperiod 1st week, 2nd week, 3rd 4th and 5thweek respectively. The reduction efficiency of BOD at 7 days was not significant. But the removal efficiency of BOD is very high at 35 days detention period.

Removal Efficiency of Chemical oxygen demand (C.O.D.)at different retention time

Sl no	Detention time(days)	Concentration of COD	
		Heliconia	Yellow canna
1	0	2300	2300
2	7	2000	1921
3	14	1500	1333
4	21	800	810
5	28	515	490
6	35	380	350

Table 4: Changes in Chemical oxygen demand. of the waste water during treatment with two selected plants.

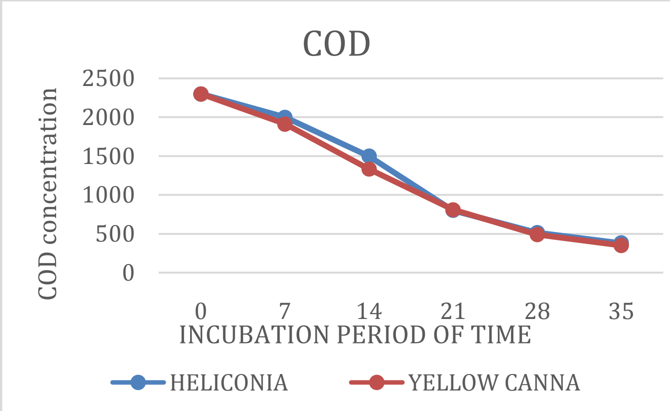

Figure 4: Changes in COD of waste water from the sugar industry throughout treatment at two specific plants.

The removal efficiency of COD was 16.48%, 42.04%, 64.78% ,78.69% and 84.78% at various detention times of 7, 14, 21, 28 and 35 days,The removal efficiency of COD was lesscompared to BOD reduction.

Removal of Total dissolved solids at distinct retaining hours

Table 5: Changes in T.D.S. of the waste water during the treatment with selected plants

Sl no	Incubation period (days)	Concentration of TDS	
		Heliconia	Yellow canna
1	0	2700	2700
2	7	2100	1995
3	14	2000	1556
4	21	950	885
5	28	800	790
6	35	550	500

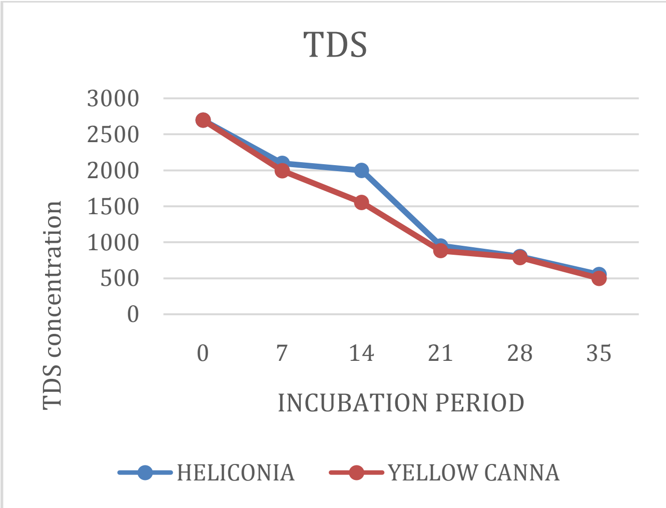

Figure5 Changes in the T.D.S of the waste water during the treatment with selected two plants,

The reduction of TDS in dairy wastewater is 26.11%,42.93 %, 44.26% ,70.74% 81.48% at 7, 14, 21,28 and 35days retention time in that order.

On first week only 6% TDS was reduced and at last week i.e. 28 days retention time TDS is reduced to 67.2%.

Over All Performance of Constructed Wet Land

Table 6average percentage removal efficiency of all parameters of heliconia and yellow canna species

Parameters	**Heliconia**				**Yellow Canna**			
	7 Days	14 Days	21 Days	35 Days	7 Days	14 Days	21 Days	35 Days
pH	7.27	13.56	20.3	23.9	12.07	15	16.4	66.66
DO	47.6	51.75	62.06	66.66	45	52.17	60.7	83.47
BOD	26.6	58.13	63.66	90.53	40	52	56.6	79.63
COD	16.48	42.04	64.78	84.78	13	34.87	65.21	86.66
TDS	26.11	42.93	67.22	81.48	22.2	25.92	64.81	79.63
Chloride	16.4	25.57	44.26	58.365	10.65	19.67	49.18	56.065
Sulphates	8.4	19.57	23.61	47.06	1.85	3.7	22.83	42.6

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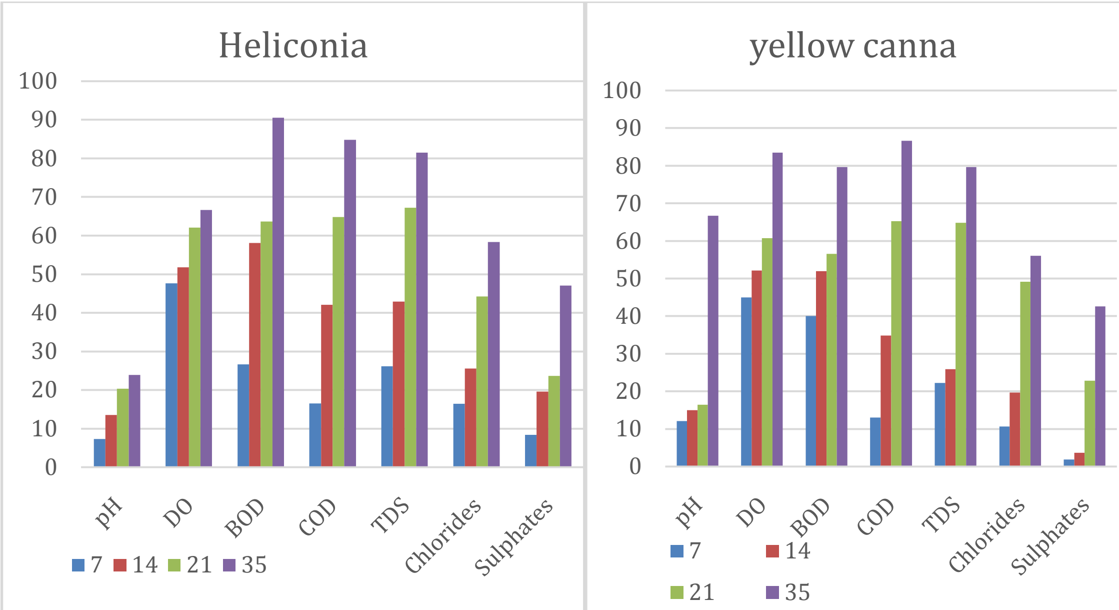

Figure4(a) and 4(b) shows average removal efficiency of all parameter with heliconia and yellow canna respectively.

V. CONCLUSION

Evolved from the test conducting on influent and effluent of various parameters of sugar factory effluent in artificial constructed wetland the following conclusion are madeConstructed wetlands are low cost and efficient and effective treatment technique for sugar factory effluent.heliconia and yellow canna species planted in horizontal flow constructed wetlands to achieve more removal efficiencies for BOD, COD DO and TDS, less removal efficiency for chloride and sulphate.Compared to heliconia plants, yellow canna plants is maximum removal efficiency for BOD and COD at 35days retention time of 90.69 % and 85.10 % respectively. Test results are found that various parameters removal efficiency is reduced as the sugar factory effluent passed through constructed wetland.Experiment was managed by different HRT of 7, 14 , 21, 28 , and 35 days. Several parameters show different removal efficiencies at different HRT. The characteristics of sugar factory effluent depend on the method of sugar manufacturing process, The sugar industries in India produce roughly 1,000 L of sugar industry effluent for every tonne of sugar cane crushed, which means that throughout the processing of sugarcane, massive amounts of water will be discharged as waste water.

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