WASTE WATER TREATMENT BY AQUATIC PLANTS USING CONSTRUCTED WETLANDS

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Abstract: **In wastewater engineering, one of the most sophisticated methods of wastewater Treatment is the tertiary treatment or biological treatment. A large number of inputs in the form of capital investment and energy have been placed for few decades now for meeting up the wastewater treatment objectives. To compensate these costs, natural wastewater treatment technologies, particularly the application of aquatic plants for wastewater treatment have been considered for quite long. The ability of aquatic ecosystem, mainly the aquatic plants to carry out wastewater purification has been exploited and this forms one of the major principles for natural wastewater treatment technologies. This study report, constitute of various underlying concepts and principals involved in the wastewater treatment using aquatic plants. The report also present the results obtained from the research study carried to investigate the treatment or removal efficiency of aquatic plants to remove pollutants from wastewater via constructed wetland technology. A generalized criterion for selection of aquatic plants has also been presented after undertaking different literature study. From the experimental work, it was evident that aquatic plant brings about significant removal rate when design for optimum operating conditions. Aquatic plant systems are as valid as land treatment systems or conventional systems, but each has its strong and weak points. Aquatic plants are not the answer to every problem, but they should at least be considered during design reviews. Small communities with some open land are prime candidates for an aquatic plant system. More attention needs to be devoted to macrophytes species selection for maximizing the treatment performances.**

Keywords: **Waste Water Treatment, constructed wetlands, treatment using aquatic plants.**

INTRODUCTION

The world we live as of today is in a verge of rapid socio-economic urbanization, industrialization along with increasing population growth. This has led to the increased pollution load on natural water bodies. Water pollution is now considered as one the most pressing environmental concerns, resulting in scarcity and stress in clean water availability. Till now the wastewater treatment approach has mainly been focused on the conventional mechanized treatment systems. Since such system typically bears significant capital investments and energy inputs, this approach for small rural communities seems marginally inappropriate. This has led to the stimulation for the development of alternative wastewater treatment systems, fairly efficient and less expensive to operate, than conventional wastewater treatment systems. One of the emerging technologies to this alternative is the wetland ecosystem, in particular “constructed wetlands”.

LITERATURE

Vertical subsurface flow constructed wetland (as in the present study) an aerobic condition prevails in the water layer just below the surface and anaerobic condition in the deeper zone within the bed, the elimination of NH4 + from the wetland system can be attributed to nitrification at the surface layer within each treatment cell.

The wastewater to be treated efficiently, the effectiveness of plant species depends upon the components of the wastewater, age and seasonal performance, the colonization characteristics of certain groups of microorganisms, the interactions between biogenic compounds and particular contaminants (wastewater components) and the roots/rhizomes.

57 wetlands from around the world have been collated to investigate whether wetlands affect the nutrient loading of water draining through them; the majority of wetlands reduced nutrient loading and there was little difference in the proportion of wetlands that reduced N to those that reduced P loading.
One of the major constraints to field-scale CW systems is the requirement of a relatively large land area that is not readily available. However, unlike traditional biological treatment systems, no specific guidelines exist for designing a CW system. Components of a CW such as the selection of plant species for their treatment efficiency with the nature of wastewater or the variation in hydraulic loading and hydraulic retention time, which influence several other design parameters, have not been evaluated for different climatic regions. Shorter HRTs translate into smaller land requirement and therefore have an implication for better acceptability of CW systems in developing countries like India. Therefore, studies have been initiated to select optimal design factors suited to subtropical monsoonal climate of India by developing a vertical subsurface flow (VSSF) CW system for secondary treated effluents of a milk-processing plant in Delhi. An evaluation of three most common wetland plants (Typha angustata, Phragmites karka and Scirpus littoralis) at a fixed HRT of 3 days brought out significant differences in their treatment efficiency, with T. angustata being more efficient than the other two.

CONSTRUCTION WETLAND

The size of wetland is 6’ x 4’x 3’. The walls of wetland were constructed with masonry walls. The bed of the wetland is made of concrete. The bed is given with a slope of 1:20. The inner side of the walls is plastered with cement mortar of ratio 1:4. As shown in Figure 1

Figure 1 Constructed Wetland

The wet land is provided with an out let in the bottom side from which the treated water comes out. The wetland was provided with a storage tank of 210 litres capacity

EXPERIMENTAL WORK

The experimental tests contain 3 tests performed on constructed wetland water sample. All water sample were tested using the septic tank is and underground tank which receives wastewater from the toilets. Holding tank of 210 liters’ capacity has been installed to collect the wastewater.

1. Chemical Oxygen Demand (COD)

Chemical oxygen demand test is carried out to indirectly determine the number of organic compounds as pollutant that is present in the wastewater. It is the measure of oxygen content in water consumed within the chemical oxidation of pollutants and is expressed in milligram per liter (mg/l). The “Redox titration” method has been adopted to carry out the test for COD.
Calculated using the following equation;

Chemical Oxygen demand $=\frac{(A-B)\times N\times 8000}{v}$mg/l

Where; A = Volume of FAS used for blank (ml).
B= Volume of FAS used for blank (ml).
N = Normality of Ferrous ammonium sulphate solution.
V = Volume of Sample used (ml).

2. Alkalinity

Alkalinity of influent and effluent of pilot CWs has been measured using the titration method.
Alkalinity was calculated using the formula:

$Alkalinity = \frac{A\times N\times 50000}{ml\ of\ titrant\ used}$,mg/l as CaCO3

Where; A= ml of titrant used to reach end point.
N= Normality of titrant used.

3. Biological Oxygen demand (BOD)

5-day BOD of the chosen samples has been measured by using bottle incubation method at 20°C. In order to prepare the dilution water, the distilled water was taken in plastic bucket and then phosphate buffer, magnesium sulphate, calcium chloride and ferric chloride solution were added as a nutrient the prepared solution was aerated with the help of diffuser for 4 hours.
It is evaluated by using the equation:

$$BOD = \frac{Di - Df}{volumetric\ fraction(ml) of titrant\ used}, mg/l$$

RESULTS AND DISCUSSION

The different properties of the influent and the effluent from both the planted and the control bed for different flow rate have been shown \ below respectively. The removal efficiency of each parameter for different flow rate has been presented. Depending upon the characteristics of water

Table 1 Wastewater characteristics at 200 LPD flow rate

Test Conducted	Chemical Oxygen Demand(COD)	Alaknity	Biological Oxygen Demand(BOD)
Result at inlet	112	448	82.25
Planted Bed	39	129	25.05
Control Bed	70	355	60
Removal efficiency of planted bed	64.37	71.16	69.54
Removal efficiency of control bed	58.32	26.12	27.01

Table 2 Wastewater characteristics at 250 LPD flow rate

Test Conducted	Chemical Oxygen Demand(COD)	Alaknity	Biological Oxygen Demand(BOD)
Result at inlet	112	448	82.25
Planted Bed	42.11	141	23
Control Bed	50.05	341.37	60
Removal efficiency of planted bed	62.4	68.5	68.2
Removal efficiency of control bed	55.31	23.8	26.5

Table 3 Wastewater characteristics at 300 LPD flow rate

Test Conducted	Chemical Oxygen Demand(COD)	Alaknity	Biological Oxygen Demand(BOD)
Result at inlet	112	448	82.25
Planted Bed	44.8	161.19	29.36
Control Bed	55.78	352.19	62.26
Removal efficiency of planted bed	60.01	64.02	64.3
Removal efficiency of control bed	50.2	21.04	24.3

Table 4 Wastewater characteristics at 350 LPD flow rate

Test Conducted	Chemical Oxygen Demand(COD)	Alaknity	Biological Oxygen Demand(BOD)
Result at inlet	112	448	82.25
Planted Bed	55.865	186.816	30.089
Control Bed	66.494	374.04	66.038
Removal efficiency of planted bed	50.12	58.3	52.838
Removal efficiency of control bed	40.63	16.5	19.65

Table 5 Wastewater characteristics at 400 LPD flow rate

Test Conducted	Chemical Oxygen Demand(COD)	Alaknity	Biological Oxygen Demand(BOD)
Result at inlet	112	448	82.25
Planted Bed	65.968	221.312	48.21
Control Bed	72.766	391.104	69.542
Removal efficiency of planted bed	41.10	50.6	41.38
Removal efficiency of control bed	35.03	12.7	15.45

CONCLUSION

[1] To be understood that the evaluation of aquatic plant wastewater treatment capability, presented in the present study has been investigated for a small pilot-scale wetland with small bed area and for small flow rates ranging from 200 LPD to 400 LPD.

[2] Also the experimental work results presented are of a small duration time of 6 months.

[3] So the direct implementation on full scale may not be justifiable. But nevertheless a strong implication can be anticipated illustrating that the aquatic plants can bring about significant wastewater treatment when designed and operated meticulously.

[4] From the study, it is quite evident that the planted bed is capable of substantial removal of pollutants.

[5] Percentage removal capacity of about 75% to almost 88% for different wastewater pollutants of concern, at lowest flow rate of 200LPD was obtained.
[6] It was also observed that with the gradual increase in flow rate was the removal performance percentage was decreased.

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