Performance Evaluation of Typha Latifolia in Treating Domestic Wastewater by Naturally and Artificially Aerated Vertical Flow Constructed Wetland

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Abstract- *With the increasing industrialization there is increase in the gap between the wastewater generation and availability of economical wastewater treatment plants. The natural method of treatment can be used to fulfill this gap. Constructed wetland is a natural treatment system which has low cost and minimum operational and maintenance cost. The natural method has some limitation in treatment due to insufficient oxygen present in the root zone of the plant. This paper is an attempt to evaluate the performance efficiency of naturally aerated and artificially aerated constructed wetland. For artificial aeration, air pump was used which was uniformly circulated in the beds. The lab-scale model was made to check performance of domestic wastewater (DWW) treatment with base media of brick pats, coal and aggregate in three layers from bottom to top respectively of height 120 mm each. The artificially aerated vertical flow constructed wetland named as AVFCW and naturally aerated vertical flow constructed wetland was names as NVFCW. Typha latifolia plant was used with inlet and outlet arrangements are made for vertical flow constructed wetland. The performance was checked for 4, 8, 12, 24, 48 hours. The performance increases as the detention time increases. The results clearly indicates maximum removal rate for COD, conductivity, TDS, pH in NVFCW and AVFCW was 49.12%, 67.05%, 56.89%, 65.88%, 49.12%, 61.87%, 6.44%, 9.26% respectively for the retention time of 2 days. As the HRT increases the efficiency increases.*

Keywords- About Constructed Wetland, Artificial aeration, Coal, Brick Pats, Aggregate, Typha latifolia, Domestic Wastewater.

I. INTRODUCTION

These instructions give you guidelines for preparing papers Treatments of domestic wastewater in urban areas are mostly done by municipal treatment plants but in case of rural areas there is no such provision in developing countries. For the treatment in such areas constructed wetland is one of the promising technology for treatment of wastewater. The cost of constructed wetland is very low requires less maintenance and running cost as compare to conventional treatment plant [11]. The pollutants are removed by the physiochemical and biological process that are taking place in the beds of the system. Vertical flow constructed wetland (VFCW) have successfully used for the treatment of domestic wastewater [10] due to high oxygen transfer capacity, high hydraulic loading, nutrients removal and smaller size. The use of constructed wetland is now accepted as low cost technology especially benefit for small towns and rural areas where cost of construction of treatment plant cannot be afforded. Vertical flow constructed wetland system have greater oxygen transport ability then horizontal subsurface flow bed for treating all types of wastewater [3][4][7]. Constructed wetlands are natural treatment system filled with base material like sand or gravel with vegetation [8].

This paper discusses about dealing with less oxygen content in constructed wetland system, for this two parallel lab scale vertical flow constructed wetland with aeration system (AVFCW) and naturally aerated system (NVFCW) designed to check its performances in treating domestic wastewater.

II. METHODOLOGY

Use all methodologies used with paper. These instructions The experimental setup for constructed wetlands for domestic wastewater treatment is consist of a circular bucket having dimensions as average diameter of 30 cm and height 40 cm having 25 liters of water holding capacity. There are two buckets used for preparing CWs models one buckets is used for the implementation of artificial aerated constructed wetland (AVFCW) and another buckets is used for naturally aerated constructed wetland (NVFCW).

Fig -1: Actual VFCW unit with a supplementary aeration device.

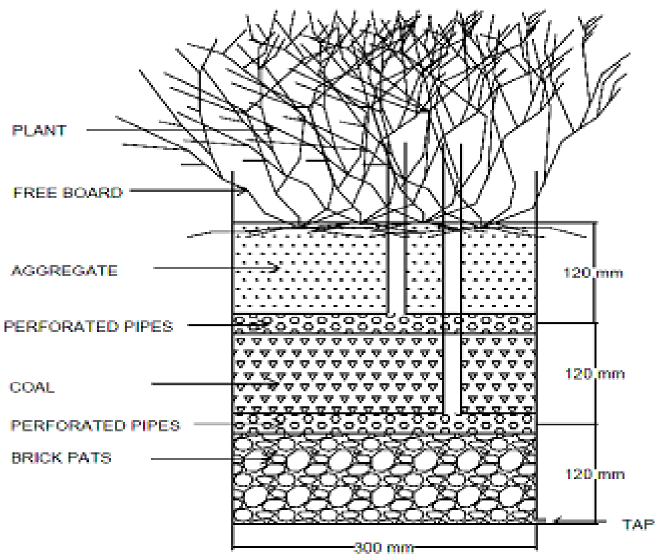

Fig -2: Sectional view of VFCW unit with a supplementary aeration device.

2.1 Naturally Aerated Vertical Flow Constructed Wetland Setup

In naturally aerated vertical flow constructed wetland model setup, the bucket is cleaned from inside by water. A hole is made at side of bottom of model to make a provision for the outlet; at this hole a tap is provided.

In bottom of model a layer of brick pieces is provided in the CW model. The broken pieces of bricks are then soaked in water to absorb water for 24 hrs, dried to remove bricks powder and then dried. Then these pieces are layered below coal layer in such a manner that it should not choke the top surface of layer. The thickness of layer of broken bricks pieces provided was 12 cm.

Middle layer of coal is provided; initially coal is broken into pieces of sizes in between 10 mm to 25 mm and kept in water to wash off the powder form of coal over the surface of broken pieces. All these pieces are washed again and again until the clear water is remained in washing container. The thickness of layer of coal pieces provided was 12 cm.

Top layer of stone chips is provided. The sizes of these stone chips were ranging from 10 mm to 20 mm. These stone chips also washed by clean water until the soil particles get washed off leaving behind clear water. This top layer of stone chips is provided above coal and thickness of 12 cm.

The freeboard of 4 cm is provided for feeding wastewater. After providing all three layers vegetation is provided by planting Typha latifolia. For seeding of Typha latifolia locally known as pankanis collected from the local site were planted into each unit. The plant was cut from the root and washed with clean water no. of time and was planted in the two VFCW units

2.2 Artificially Aerated Vertical Flow Constructed Wetland Setup

In artificially aerated vertical flow constructed wetland setup a tap is provided in similar manner as that of naturally aerated vertical flow constructed wetland. In this model an additional assembly of piping system consists of two pipes is provided so as to supply a compressed air from air pump to bottom of model and middle layer in order to increase dissolved oxygen (DO) level in wastewater to be treated. The opening of this two pipe assembly is located in such a way that it will provide uniform aeration in the model.

After providing piping assembly for aeration layers of coal pieces, broken bricks and stone chips is provided as in case of artificially aerated vertical flow constructed wetland. Also Typha latifolia are planted as in previous case.

In artificially aerated vertical flow constructed wetland model compressed air is passed through air pump. Two air pumps are used to supply compressed air having two nozzles each which gives constant air supply at the rate of 4 L/min/m2 from each nozzle. This means each air pump supplies 2x4 L/min/m2 i.e. 8 L/min/m2 of air supply at a constant rate from one air pump. Total air supply in SI unit can be calculated as;

Air supply = 16 L/min/m2

= 16 x 10-3 m3 of air/min/m2

In each constructed wetland models Typha latifolia plants are rooted having 3 to 5 shoots in each plants and these plants were trimmed up to 8 inches height from top surface of stone chips layer and regular height and number of shoots of the plants were observed.

III. RESULTS AND DISCUSSION

3.1 System start-up

The two units were started up after the plant was fully grown (45 days) by introducing the domestic wastewater (DWW). Treatment was calculated using the following formula:

Treatment (T) (%) = (Mean inlet concentration *Ci* – Mean outlet concentration *Co*) X 100/ (Mean inlet concentration *Ci*)

The results of the parameters which were checked are as follows:

1. COD

COD levels of influent and effluent domestic wastewater is plotted chart 1 to chart 4 showing the % decrement for 4, 8, 12, 24 and 48 hrs. In NVFCW range of COD value is decreasing and achieving more efficiency as the HTR is increases due to the uptake of nutrients by plants. The efficiency of COD in NVFCW for OLR 0.34 kg/m3/day is 7.57%, 14.91%, 39.28%, 44.87% and 49.12% for HRT 4 hrs, 8 hrs, 12 hrs, 24 hrs and 48 hrs respectively. In case of AVFCW COD range is decreasing in more amount due the provision of aeration as it is oxidizing the waste. The overall efficiency of COD level in AVFCW is 15.22%, 20.26%, 49.30%, 57.60% and 67.05% for HRT 4 hrs, 8 hrs, 12 hrs, 24 hrs and 48 hrs respectively.

2. DO

The average range of influent DO is recorded as 0 mg/L having minimum value 0 mg/L and maximum value 0 mg/L. In NVFCW range of DO value is increasing and achieving more efficiency as the HRT is increasing. But in case of AVFCW DO range is increasing in more amount as aeration is provided in this test.

The value of DO in NVFCW is 0.533, 0.733, 1.1, 1.43 and 1.56 for HRT 4 hrs, 8 hrs, 12 hrs, 24 hrs and 48 hrs. In case of AVFCW DO range is increasing in more amounts due the provision of aeration. The overall value of DO level in AVFCW is 1.06, 1.87, 2.23, 3.2 and 4.0 for HRT 4 hrs, 8 hrs, 12 hrs, 24hrs and 48 hrs respectively.

3. TDS

TDS levels for influent and effluent domestic wastewater is plotted chart 1 to chart 4 showing the % decrement for 4, 8, 12, 24 and 48 hrs. The TDS reduced due to the processes of sedimentation, filtration bacterial decomposition and adsorption. The efficiency in TDS by NVFCW is 5.5%, 13.51%, 22.15%, 25.04% and 49.12% for HRT 4 hrs, 8 hrs, 12 hrs, 24 hrs and 48 hrs respectively.

The overall efficiency in hardness removal by AVFCW is 11.05%, 15.92%, 25.81%, 42.19% and 61.87% for HRT 4 hrs, 8 hrs, 12 hrs, 24 hrs and 48 hrs respectively

4. pH

pH is the hydrogen ion concentrations present in water. pH values goes down due toacidification. The change in value of pH is not observed that much as the CWs maintains the pH value nearly equals to neutral and the pH of domestic wastewater was slightly acidic i.e. around neutral value, pH values goes down due to acidification.

5. Conductivity

Conductivity is the measure of ability of water to conduct electricity. Change in conductivity levels for influent and effluent domestic wastewater is plotted chart 1 to chart 4 showing the % decrement for 4, 8, 12, 24 and 48 hrs. .
The conductivity levels are increasing in NVFCW and AVFCW as the DO level is increasing. In AVFCW as the DO level is high; conductivity is also high due to aeration.

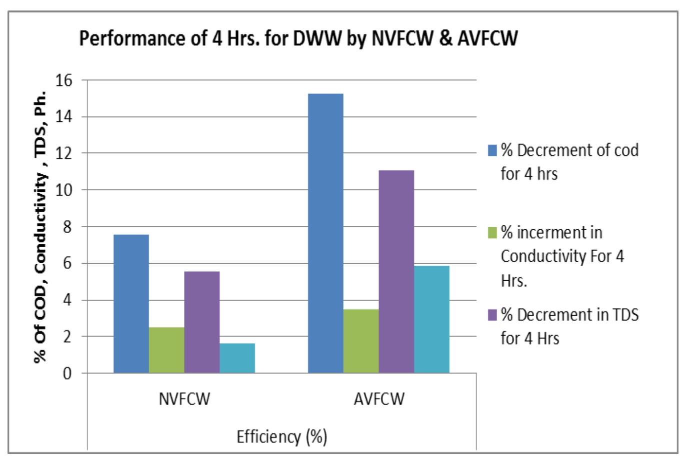

Chart -1: Chart showing performance of 4 hrs.

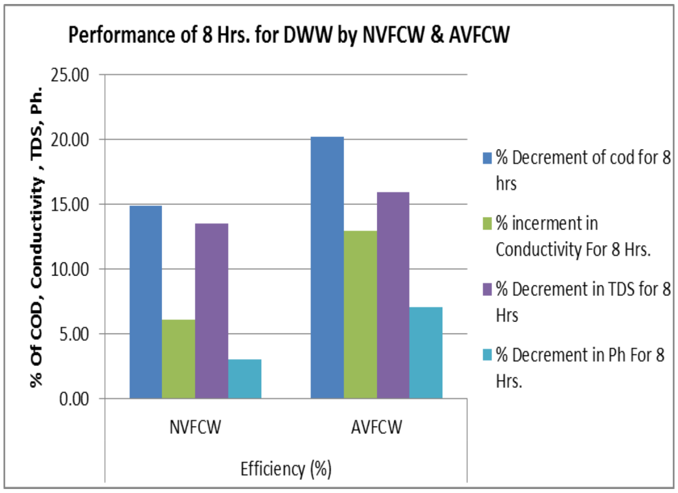

Chart -2: Chart showing performance of 8 hrs.

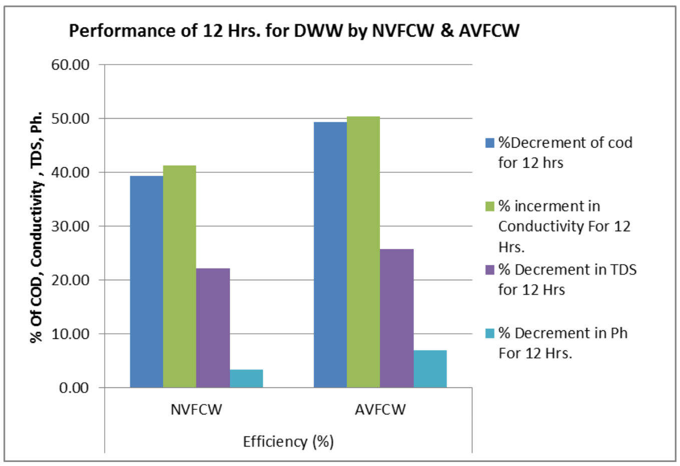

Chart -3: Chart showing performance of 12 hrs.

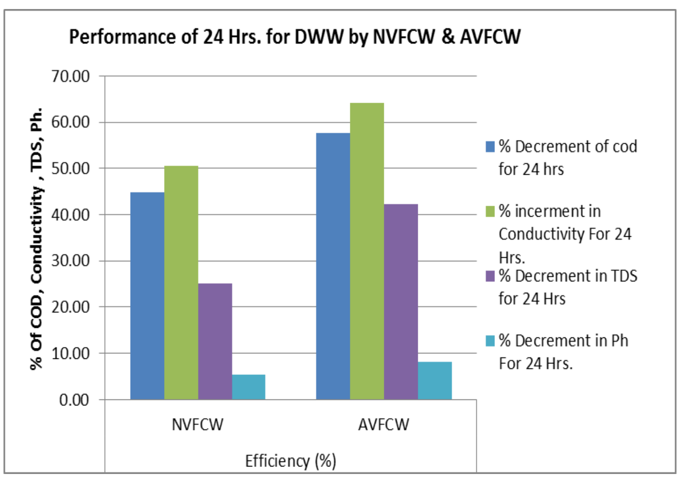

Chart -4: Chart showing performance of 24 hrs.

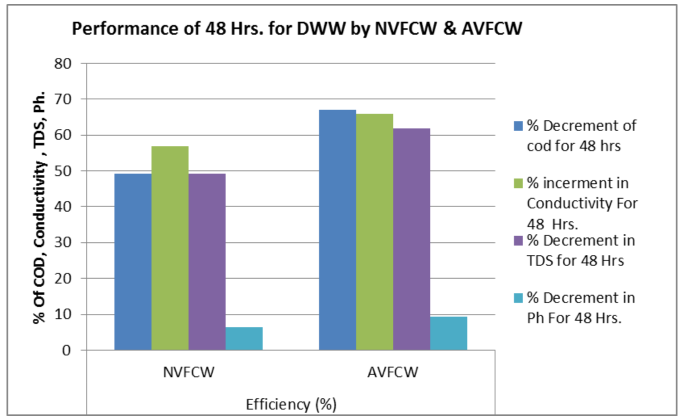

Chart -5: Chart showing performance of 48 hrs.

IV. CONCLUSIONS

The vertical flow constructed wetland has proved to be an efficient method with the use of plant, microorganisms and the base material for pollutant removal. As the HRT increased to 48 hours the efficiency also increases. The base material i.e. combination of brick pats, coal and aggregate was efficient in pollutant removal. The artificially aerated unit has a better efficiency than naturally aerated one.

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