Groundwater Treatment by Artificially and Naturally Aerated Constructed Wetland

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Abstract- *The use of constructed wetland is increasing with the previous record shown its effectiveness in the removing the pollutant from wastewater of various sources. It is one of the reliable as well as environmental friendly technologies. The basic limitation in its treatment performance is the absence of sufficient oxygen and if the amount of oxygen content is increased in the wastewater the treatment performance can be improved. In this paper the performance efficiency in improving removing mechanisms with artificially aerated and naturally aerated constructed wetland are checked. The lab scale model consists of three bed layer one over the other of brick pats in bottom, coal in middle and aggregate at the top. The performance was observed for 4 hr., 8hr. and 12 hr. The parameter included was pH, Hardness, TDS, DO. The results shown that the artificially aerated Constructed Wetland has a better performance in increasing the DO of the underground water. Initially till the plant growth it was irrigated with underground water and to check the performance of the underground water.*

Keywords- Artificially Aerated CW, Wastewater, Underground water, Coal, Aggregate, Brick pats.

I. INTRODUCTION

With the increasing demand of low energy consumption treatment plants, constructed wetland is one of such technology which uses low energy and cost so it is one of the best alternatives to conventional treatment systems. This system is effective mainly for village area that is the areas where the cost of construction are the main problem [6][4][2].

The treatment is not limited to any specific type of wastewater but to all types of wastewater as a cost effective method. The efficiency of constructed wetland depends on the type of wetland design, type of system, material used; location and type of vegetation selected [8] [7]. Constructed wetland subsurface flow consists of a layer of bed planted with vegetation so that roots can hold the bed and wastewater is passed through the media (porous) and then collected to the outlet. The pollutants are removed by microbial degradation, chemical and physical process in a network of aerobic , anoxic and anaerobic zones with aerobic zone limited only of area adjacent to the roots where oxygen leaks to the substrate[3][9].

The performance potential of different plants was carried out for different medium for the nutrients removal and concluded that Typha latifolia has good growth rate in stone grit medium [5].

II. MATERIAL AND METHOD

A. Site Description

Two lab scale model for domestic wastewater treatment by artificially and naturally Aerated constructed wetland was designed to treat Wastewater situated in Wagholi, (N 18.52028 and E 73.85667) pune. The prevailing climate in wagholi area is known as a local steppe climate [10].The average annual temperature in wagholi is 25.0 °C and the rainfall is 603 mm.

B. Experimental Design

Two parallel laboratory scale VFCW (Vertical Flow Constructed Wetland) (made up of plastic material) of dimension 0.3m x 0.4m (diameter x height) were uniformly designed. The units with and without aeration were designated as AVFCW (Artificial Aerated Vertical Flow Constructed Wetland) and NVFCW (Natural Aerated Vertical Flow Constructed Wetland) respectively. Two PVC pipes of diameter 20mm (ϕ) for artificial and natural aeration was laid in both unit and was laid in the layer between bottom, middle layer and top layer of the supporting medium. The bottom of aeration pipes were punched with 2mm holes.

The support media was filled up uniformly inside the two units. From top to bottom the support material were at top aggregate from the local construction site, at middle charcoal collected from the local market and at bottom brick pats.

For seeding of Typha latifolia locally known as pankanis collected from the local site located at wagholi were planted into each unit. All the material i.e. support material was washed with acid and clean water 3 times for the removal of any unwanted material and seeding plant was cut from the root and washed with clean water. Plants were planted in the two VFCW (Vertical Flow Constructed Wetland) units at a depth of 6 inch. The characteristics are shown in the Table 1.

Fig.1: Seeding plant Site

Fig.2: Lab Scale model

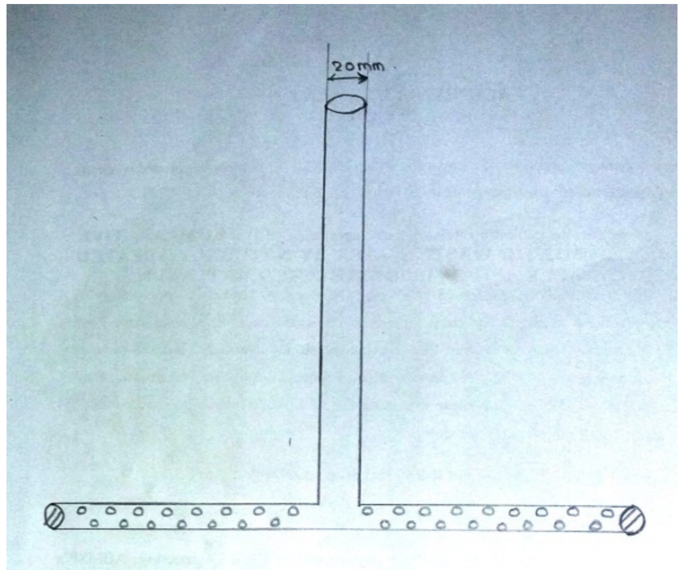

Fig.3: Aeration Pipe inside model

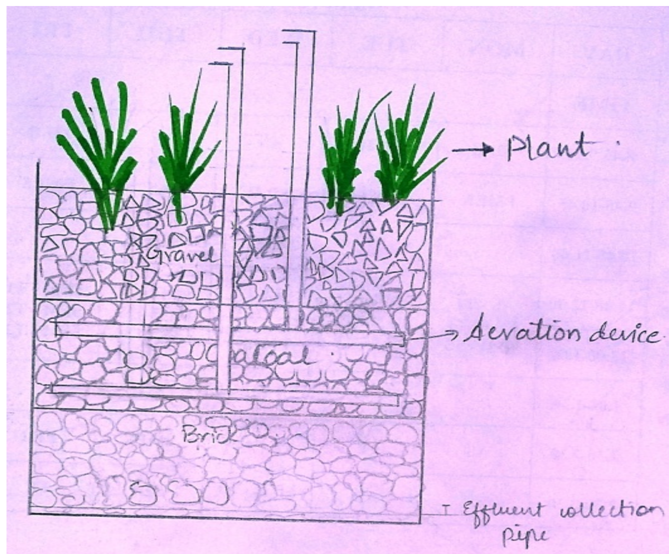

Fig.4: Section View of VFCW

Table 1: Experimental setup

Sr.no.	Particular	Characteristics
1	Name of plant	Typha Latifolia
2	Size of model (circular)	400mm x 300mm
3	Area of bed	0.0706m2
4	Total volume	25 L
5	Total height of bed	3600 mm
6	Total height of supporting media	3400 mm
7	No. of layers of supporting media	Three
8	Depth of brick pats	120 mm
9	Depth of aggregate	120 mm
10	Plant density	56 plant per m2
11	Depth of coal	120 mm

C. Parameter and method of analysis

The lab scale model was assessed for its performance in terms of underground water quality parameter pH, hardness, TDS, dissolved oxygen. The method of analysis is given in table 2 [2].

Table 2: Parameter used and method of analysis

Sr. No.	Parameter	Methods
1	pH value,	Electric pH Meter
2	Hardness	EDTA Titration Method
3	Dissolved Oxygen	DO fixation Method
4	Total Dissolved Solid	Electrical Conductivity Meter Cell Constant Method

III. RESULT AND DISCUSSION

The study of the initial working of artificially aerated and naturally aerated vertical flow constructed wetland the underground water sample was analysed for parameter such as pH, Hardness, TDS, DO. The sampling in both inlet and outlet was carried out on hourly basin i.e. 4hour, 8 hour and 12 hour duration and performance was compared for the efficiency of the working model. The parameters which are tested are discussed below:

A. pH Parameter

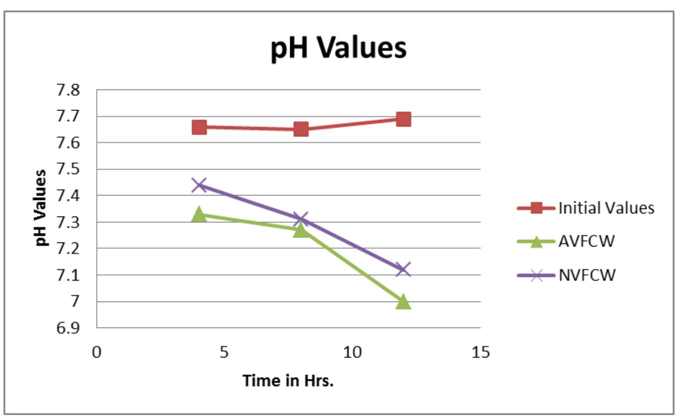

Fig.5: Performance evaluation for pH change in groundwater.

Fig. 5 describes the variation of pH parameter during the monitoring period. The inlet concentration ranges from 7.65 -7.69 while that of the outlet concentration for 4 hr. to 12 hr. ranges from 7.1 – 7.33 for AVFCW and 7.12- 7.44 for NVFCW. From the performance of pH value of the underground water it was observed that the pH values decreases due to some chemical reaction, physical activity and aeration. The underground water goes to acidification therefore its pH degreases.

B. Hardness

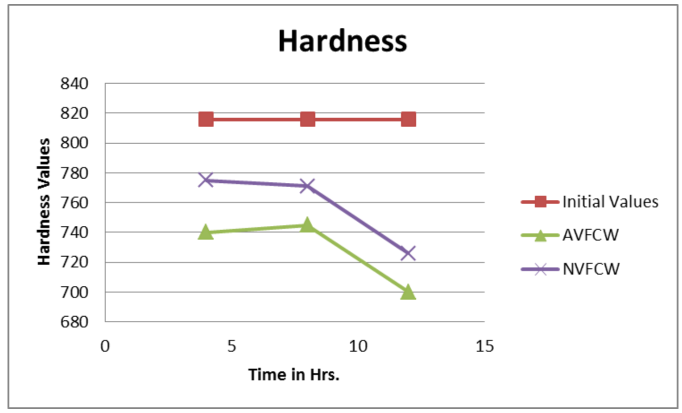

Fig.6: Performance evaluation for Hardness change in groundwater.

The mean performance of hardness parameter changes in groundwater is shown in fig. 6. From the result it is noted that the hardness value is very high in underground water. The CW is not effectively removes the hardness from underground water. From the two models is observed that the removal efficiency in artificially aerated CW was more than that of naturally aerated CW. It shows that Artificial Aeration affect the removal of hardness. By increasing the aeration we can remove hardness up to certain level.

C. Total Dissolved Solids

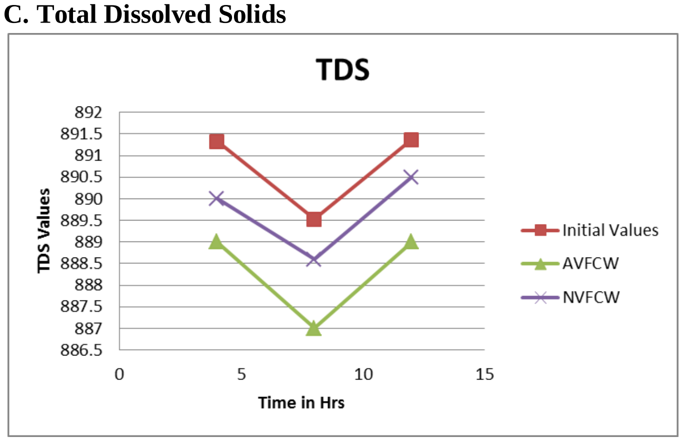

Fig.7: Performance evaluation for TDS change in groundwater.

Fig. 7 describes the variation of TDS parameter during the monitoring period. The results shows that the TDS concentration was higher in groundwater. TDS removal efficiency of Constructed wetland was found to be not very effective. In experimental condition, artificially aeration system and plants presence did not effectively remove the dissolved ions. The change in the TDS concentration shows that the CW neutralises the particle charges which are present in underground water.

D. DissolvedOxygen

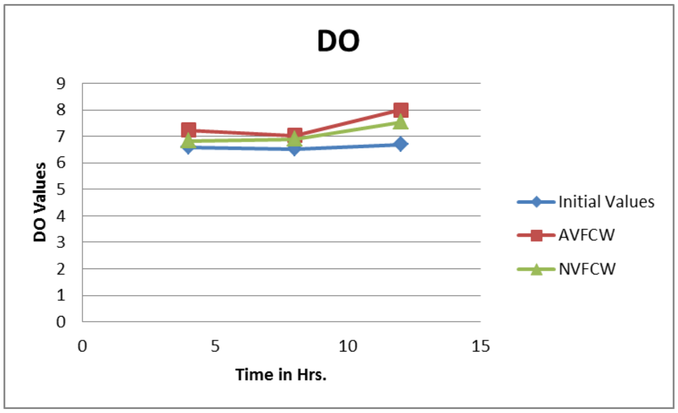

Fig.8: Performance evaluation for DO change in groundwater.

From the fig. 8 it can be observed that with the increase of retention time, the concentration of oxygen increases in the groundwater. The result shows that in the artificial aerated constructed wetland, oxygen quantity increases in the groundwater more than naturally aerated constructed wetland. In artificially aerated CWs, oxygen availability is enhanced by the presence of plants and artificially aerated system through diffusion of oxygen.

IV.CONCLUSION

A lab scale model consisting of brick pats, coal, aggregate as a filter material and artificially and naturally Constructed Wetland was developed. The performance using above base material was carried out with underground water as a feed. The following conclusions are made

1. Artificially Aerated Constructed Wetland is more efficient in improving the above parameters then Naturally Aerated Constructed Wetland.
2. Artificially Aerated Constructed Wetland are better efficiency in increasing dissolved oxygen.
3. These are not very effective in reducing TDS and hardness parameter from underground water.

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