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Constructed Wetland with Vertical Flow: A Sustainable Approach to Treat Dairy Effluent by Phytoremedeation

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Abstract-Constructed Wetlands (CW) are engineered wastewater treatment systems filled with porous media and planted with emergent wetland plants. The aim of this study was to analyze the phytoremoval effectiveness by Typha angustata and Phragmitesaustralis to treat Dairy industry effluent in CW systems as vertical flow subsurface treatment. Local wetland soil CW showed significant improvement in all parameters. Phragmitesaustralis gave 97.79% reduction in COD and 98.68% BOD whereas Ammonical Nitrogen and organic Nitrogen 99.53% and 95.42% respectively. Treatment using Typha angustata reduces COD 92.51% and 96.46% BOD while Ammonical Nitrogen and Organic Nitrogen were totally removed from the effluent. The results were also statistically verified using one way ANOVA and 2 tailed t-test Analysis. The study shows that Dairy industry effluents treated in vertical flow subsurface wetland with Phragmites austral is gives best reduction in all the parameters of water with retention time of 7HRT.

***KEYWORDS*-Constructed wetlands, Subsurface-flow, Typha angustata, Phragmitesaustralis.**

I. INTRODUCTION

Wastewater is defined as a combination of the liquid or water carried wastes removed from residence, institution, industrial & commercial establishments [1]. Nature has evolved a number of systems to eradicate the pollutions generated due to natural events. The natural cycles in the environment offer a variety of ways in which pollutants can be altered and transported. These cycles are capable to tackle pollutions due to anthropogenic activity but to a certain extent. The best possible way is to remove pollutants by phytoremediation using aquatic plants. The capacity of wetlands that are dominated by hydrophytes has ability to assimilate the nutrients and organic matter, thus treating wastewater.In recent years effective treatment is achieved by the construction or management of wetland so that environmental conditions favor rapid degradation and cleaning of effluent [1][2][3][4]. Interest was initially centered on the use of Hyacinth based treatment system. Subsequently more efficient reed bed systems were used as a substrate- plant microbial filter [5].

Bali *et. al.* (2010) [6] had studied infiltration percolation technique which is capable of completely oxidizing and decontaminating the wastewater of secondary effluents which was intermittently applied over 100m of two infiltration basin made of unsaturated coarse bed. Coulibaly*et. al.* (2008)[7] emphasized on constructed wetland planted with *Amaranthushybridus* for treating domestic wastewater. Two beds were constructed one for control batch and the other for experiment batch containing *A. hybridus* and showed that the beds planted with *A. hybridus* shows best COD reduction. In present study, sub surface flow system was used to treat Dairy effluents in batch process using two species of hydrophytes and the removal of various pollutants is discussed in detail[8][9][10].

II. METHODOLOGY

A. Experimental setup

Vertical flow constructed wetland was constructed at the Department of Life Sciences, HNG University. The constructed wetland systems had *T. angustata and P.australis* with vegetation which was located from a lake in Baspa village of Patan. The constructed wetland lab model was made up of plastic. The wastewater container had dimension of 0.82m × 0.54m × 0.73m and bed assembly is in rectangular shape. The volume of the bed is $0.32m^3$. The surface area of the bed was $0.44m^2$. The porosity of the Substrate was 100%. The inlet unit is provided with a PVC pipe along with a calibration knob. The calibration knob was adjusted that it will work for different detention period. The water which will percolate through the bed assembly will come out from the PVC tap attached at the bottom and from there it will be collected in the beakers.

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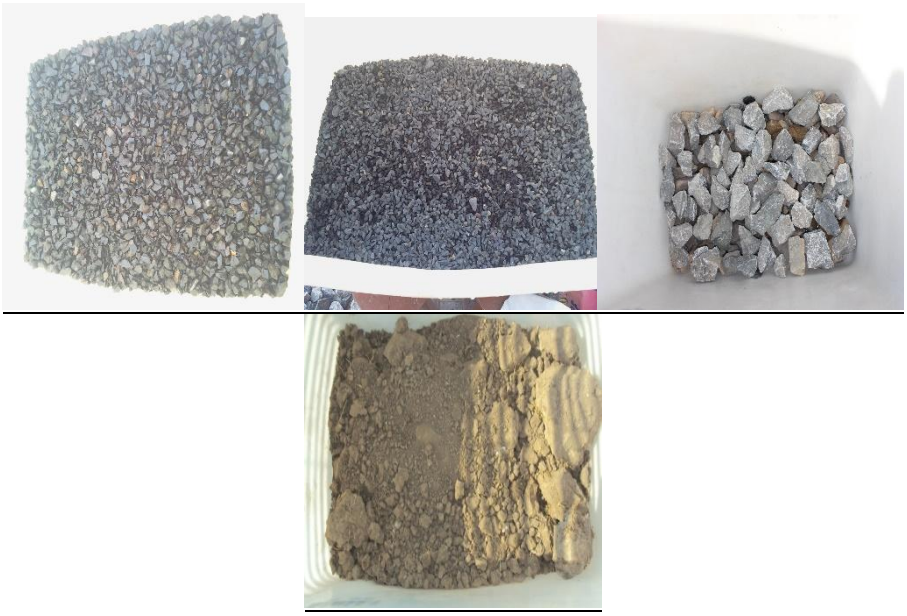
B. Preparation of Bed

The constructed wetland had a height of 0.73m in which 0.03m were left on top for loading the wastewater hence only 0.7m was used to make the wetland bed out of which 40% was used to make the wetland (Soil & Plants) and the rest 60% was used for substrate. Top layer consisted of the local soil. Before placing the soil in the bed, it was cleaned properly and was ensured, free from impurities. The soil media had a depth of 0.42m, below the soil layer very small pebbles (0.01-0.012m) were placed, the depth of pebbles layer was 0.5m. The Middle layer was made of small stones (0.02-0.03m) having a depth of 0.8m. The bottom of wetland unit was formed by big gravels (0.04-0.05m) having depth of 0.15m. 25 individual plants of each species were placed in the soil at a depth of 0.22m. The system was operated and maintained on volume based method for two set namely control and experimental. The wastewater was retained for a maximum of 7 days HRT. The flow rate was 0.012m^3/day. Samples were taken daily at an interval of 24 hr.The analysis was done as per APHA standard method for the examination of water and wastewater (21st edition). American / held association Washington.

(1) (2) (3) (4)

Fig 1: (1) Control Set, (2) *P.australis*Set, (3) *T. angustata* Set, (4) Baspa Village in Google maps[11].



(1) (2) (3) (4)

Fig 2: (1) First layer of Model, (2) Second layer of Model, (3) Third layer of Model, (4) Top layer of Wetland Soil [11].

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III. RESULTS AND DISCUSSION

During the experiment of 7 days, it was noted that there was a marked correction in the pH of the effluent. The color of the effluent was found to faint from dark white to colorless. Also both the study plants gave a good increase in height and number. *P.australis*height increased from 0.1m to 0.45m and their number increased from 25 to 45 while *T. angustata* height increased from 0.2m to 0.45m and the number increased from 25 to 35.

Table 1 : Concentration of various physico chemical parameters of effluents at 7HRT after treatment of phytoremediation

Parameter	**Initial**	**7 HRT**	**Experimental**	
Data in ppm		**Control**	***Phragmitesaustralis***	***Typha angustata***
COD	1335.84	805.34	29.47	100
BOD	897.82	287.1	11.85	31.74
Total Hardness	400	363.33	120	96.67
Sulphate	6.58	3.15	0.16	0.33
Phosphorus	6.07	2.6	1.51	0.04
TDS	1200	750	640	500
TSS	600	150	N.D	N.D
Chloride	215.56	250.32	70.07	25.02
NO2	27.52	15.29	0.003	0.08
NO3	0.06	0.02	N.D	N.D
NH3-N	1196.53	679.76	5.6	N.D
Organic Nitrogen	179.76	123.01	8.21	N.D

(Note: N.D = Not Detectable)

The above table shows concentration of various parameters in the effluent at initial stage, without any treatment at 7HRT and after the treatment by two hydrophyte species at 7HRT. Table 1 reveals that both the hydrophyte species are able improve the quality of effluents at 7 HRT; however effluents treated with *T. angustata*gives better results by significant reduction in concentration of water parameters. All the results are found significant at 5% significant level through one way Analysis of Variance (ANOVA) except dissolved oxygen with F value 1.51. The values of F at 5% level for ANOVA are 17.64 for COD, 16.96 for BOD, 764.86 for ammonical Nitrogen and 36.24 for organic Nitrogen. Further 2 tailed Student's t test has been employed to know the better performance of hydrophyte species. The test revealed that P.australis is more potent with respect to treating the dairy industry effluent. Sulphate, Chloride, Ammonical Nitrogen and Organic Nitrogen were significantly decreasing by P.australis, (t= -2.8, -2.92, - 4.12 and -6.61respectively). Further, t-test also shows that P.australis is found to have more potential to treat dairy industry effluent as compared to T.angustata.

It is further observed that the wetland constructed with these plant species in vertical subsurface flow can be a better option for effluent treatment as compared to the conventional effluent treatment plants. The hydrophyte plays a vital role, due to the oxygen diffusion from their roots which helps in nutrient uptake and insulation of the bed surface. It is also observed that increase in the detention time increases the % removal of pollutants due to good water holding capacity of local soil. Maximum effluent loss was found during the *P.australis*treatment which was operated in the summer season, due to which a daily loss of 5L of effluent was recorded. *T. angustata* treatment was given in the winter season, where daily loss of 3 to 4L was recorded. The % removal for COD, BOD, ammonical and organic nitrogen were 92.51% and 96.46% and 100% respectively.

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IV. CONCLUSION

Following conclusion can be drawn by using laboratory scale model, working on local soil, substrate and with plant species of *T. angustata* and *P.australis*as Vertical Flow for 7 day retention time. The subsurface flow constructed wetland concept can offer high performance levels for almost all parameters at relatively low costs for construction and operation and maintenance. From the above study it can be concluded that P.australis show better performance with respect to pollutants up take of dairy industry effluent as compared to T.angustata

REFERENCES

[1] Metcalf and Eddy, Inc., Wastewater Engg. Treatment, disposal and reuse, 3rd edition McGraw –Hill, 1991.

[2] Borkar and Mahatme, Wastewater Treatment Using Vertical Flow Constructed Wetland, IJES Volume 2, 2011.

[3] H. Brix, Use of constructed wetlands in water pollution control: historical development, present status, and future perspectives: Water. Sci. Tech., 30(11), 209-223, 1994.

[4] K. R. Reddy, and W. F Debusk, Growth Characteristics of aquatic macrophytes cultured in nutrient enriched water: Azoiza, Duckweed and Sqivinia: Econ. Bot. (39) 200-208, 1985.

[5] B. C. Wolverton, Water Hyacinth for Controlling Water Pollution: Asian Publisher, New Delhi, India, 1981.

[6] M.Bali, M. Gueddari,R. Boukchina, Treatment of secondary wastewater effluent by infiltration percolation, Science Direct,258,pp1-4, 2010.

[7] L. Coulibaly, J. kouakou,I. Savane,G. Gourene, Domestic waste water treatment with a vertical completely drained pilot scale constructed wet land planted with Amaranthushy bridus:African journal of biotechnology,7(15),pp 2656-2664, 2008.

[8] R. L. Knight, Wildlife habitat and public use benefits of treatment wetlands: Water Sci. Tech.35 (5). 35-43,1997.

[9] A. Upadhyay, Aquatic Plants for the wastewater Treatment: Daya Publishing House, Delhi, India, 2004.

[10] J. Vymazal, Constructed wetland for Wastewater treatment: A Review, The 12th World Lake Conference: 965-980.

[11] Patel and Dharaiya, Phytoremediation of Sugar Industry Effluent using Typha angustata and Phragmitesaustralis through Constructed Wetland: International Journal of Chemical, Biological and Physical Sciences. Sec.D: Nov.2013-Jan.2014.Vol.4.No.1:846-851. 2014.

[12] UN-Habitat, Constructed wetlands manual, Nepal, Kathmandu, 2008.