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Can a Sub Surface Flow Wetland be An Eco Tool for the Treatment of Detergent Based Effluent?

KEYWORDS: Constructed wetlands, Subsurface-flow, COD, Ammonical Nitrogen

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ABSTRACT *Constructed wetlands (CWs) are "engineered systems, designed and constructed to utilise the natural functions of wetland vegetation, soils and their microbial populations to treat contaminants in surface water, groundwater or waste streams". The aim of this study was to analyze the phytoremoval effectiveness by Typha angustata and Phragmites australis to treat Detergent industry effluent in CW systems as vertical flow subsurface treatment. Local wetland soil in CW showed significant improvement in all parameters. Phragmites australis gave 93.33% reduction in COD and 95.14% BOD whereas Ammonical Nitrogen was totally removed from the effluent and organic Nitrogen was removed upto 95.41%. Treatment using Typha angustata reduces COD 58.65% and 87.16% BOD while Ammonical Nitrogen and organic Nitrogen were reduced 39.76% and 56.79% respectively. The results were also statistically verified using one way ANOVA and 2 tailed t-test Analysis. The study shows that Detergent industry effluents treated in vertical flow subsurface wetland with Phragmites australisgives best reduction in all the parameters of water with retention time of 7HRT.*

INTRODUCTION

Wastewater is defined as a combination of the liquid or water carried wastes removed from residence, institution, industrial & commercial establishments (Metcalf and Eddy, 1991). Water is one of the most important elementsinvolvedinthecreationanddevelopmentofhealthylife. Theexponential growth of populationandindustrialization willcauseahuge lack of water if we don't start to use it in a sustainableway (Borkar and Mahatme, 2011). 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 (Reddy and Debush, 1987, Reddy and Smith, 1987). 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 (Wolverton, 1987).Kadlecet al., 2000 showed that in general the use of CWs provides a relatively simple, inexpensive, and robust solution for the treatment of water. Compared to other treatment options, CWs usually need lower operational and maintenance expenses. Additional benefits include CWs tolerance to fluctuations in fluxes and pollution loads, their facilitation of water reuse and recycling, creation of habitat for many wetland organisms, and the more aesthetic appearance of natural systems compared to technical treatment options. In present study, sub surface flow system was used to treat Detergent effluents in batch process using two species of hydrophytes and the removal of various pollutants is discussed in detail.

METHODOLOGY

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 were 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.

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. Inlet was provided at a rate of $0.012m^3$/day so as to load 50 liter of a sample. 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.

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 showed a significant increase in their height, 5±0.25 for P. australis and 4.16±0.41 in T. angustata in seven days of retention time. Moreover after seven days of retention time, we also found increase in colony size of both the plants.

The below 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 P. australis gives better results by significant reduction in concentration of water parameters. All the results

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are found significant at 5% significant level through one way Analysis of Variance (ANOVA) except organic nitrogen with F value 0.32. The values of F at 5% level for ANOVA are 7.89 for COD, 74.03 for BOD and 168.46 for ammonical Nitrogen.

Table1: Concentration of various physico chemical parameters of effluents at 7HRT after treatment of phytoremediation

Parameter	Initial	7 HRT	Experimental	
Data in ppm		Control	Phragmites australis	Typha angustata
COD	320	172.18	21.33	132.31
BOD	249.93	182.52	12.13	32.08
Total Hardness	273.33	183.33	60	110
Sulphate	0.16	N.D	N.D	N.D
Total Phosphorus	1.16	0.69	N.D	N.D
TDS	1090	540	100	700
Chloride	511.23	400.44	60.31	301.99
NO2	0.25	0.15	0.02	0.15
NO3	0.11	0.04	N.D	0.07
NH3-N	109.39	83.81	N.D	65.89
Organic Nitrogen	129.17	112	6.45	55.81

(Note: N.D = Not Detectable)

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 detergent industry effluent. Only Temperature and D.O were not significantly decreasing by P. australis, (t=8.57and 5.24 respectively). Further, t-test also show that P. australis is found to have more potential to treat detergent 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 hydrophytes 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.australistreatment 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.

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.australisas 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.australisshow better performance with respect to pollutants uptake of detergent industry effluent as compared to T. angustata with the % removal for COD, BOD, ammonical nitrogen and organic nitrogen were 93.33%, 95.14%, 100% and 95.41% respectively.

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