Available online at www.elixirpublishers.com (Elixir International Journal)

Pollution

Elixir Pollution 99 (2016) 43230-43232

ISSN: 2229-712X

Treatment of Pharmaceutical Industry Effluent using Phytoremediation Technology in Manmade Wetland

Patel Pratik A.[1] and Dharaiya Nishith A.[2]

[1]Shree Ramkrishna Institute of Computer Education & Applied Sciences, Surat – 395001

[2]Department of Life Sciences, Hemchandracharya North Gujarat University, Patan, Gujarat, India – 384265.

ARTICLE INFO

Article history:

Received: 1 March 2016;

Received in revised form: 10 October 2016;

Accepted: 18 October 2016;

Keywords

Ammonical Nitrogen,
Constructed wetlands (CW),
COD,
Subsurface-flow.

ABSTRACT

Wetlands have played a significant role as natural purification systems. The aim of this study was to analyze the phytoremoval effectiveness by Typha angustata and Phragmites australis to treat Pharmaceutical industry effluent in CW systems as vertical flow subsurface treatment. Local wetland soil in CW showed significant improvement in all parameters. Phragmites australis gave 98.36% reduction in COD and 98.93% BOD whereas Ammonical Nitrogen and organic Nitrogen were 99.39% and 86.84% respectively. Treatment using Typha angustata reduces COD 94.18% and 72.17% BOD while Ammonical Nitrogen and organic Nitrogen were reduced 97.3% and 41.21% respectively. The results were also statistically verified using one-way ANOVA and 2 tailed Student's t test Analysis. The study shows that Pharmaceutical industry effluents can be treated in vertical flow subsurface wetland with Phragmites australis, as it gives 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). 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 (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). Wolverton and McDonald, 1981 worked on treatment of organic chemical waste. In present study, sub surface flow system was used to treat Pharmaceutical effluents in batch process using two species of hydrophytes and the removal of various pollutants is discussed in detail.

Materials And Methodology

Experimental Setup:

Vertical flow constructed wetland was constructed at the Department of Life Sciences, H.N.G University. The constructed wetland systems, had T. angustata and P.australis with vegetation which were collected 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 was in rectangular shape. The volume of the bed is 0.32m3. The surface area of the bed was 0.44m2. The porosity of the Substrate was 100%. The inlet unit was 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 tap attached at the bottom and from there it will be collected for further analysis.

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 and 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 0.012m3/day so as to load 50 liter of a sample. Grab 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.

Tele:

E-mail address: env.pratik@gmail.com

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

Figure 1. (1) Control Set, (2) *P. australis* Set, (3) *T. angustata* Set, (4) Baspa Village in Google maps respectively.

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

Figure 2. (1) First layer of Model, (2) Second layer of Model, (3) Third layer of Model,(4) Top layer of Wetland Soil

Design consideration

The vertical sub surface lab model was constructed on the basis of the formula proposed by Kikuth, 1977 (Patel and Dharaiya, 2013). He proposed the following equation which is widely used for sizing of systems aimed for treating wastewater.

$$A_h = \frac{Q_d (\ln C_{in} - \ln C_{out})}{K_{BOD}}$$

A_h = Surface Area of Bed, m^2

Q_d = Average Flow Rate, 0.012 m^3/day

C_{in} = Average inlet BOD, 1311.344 mg/l

C_{out} = Average outlet BOD, 30 mg/l

K_{BOD} = Rate Constant, 0.1m/day

The percentage concentration decrease efficiency was calculated according to the formula proposed by the International Water Association (IWA, 2000).

$$\%\text{Concentration Decrease Efficiency} = \frac{Ci - Co}{Ci} \times 100$$

Ci = Inlet Concentration, mg/l

Co = Outlet Concentration, mg/l

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 black 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, it was noted that there were increase in colony size of both the study plants.

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

Parameter	**Initial (Untreated Effluent)**	**7 HRT**	**Experimental 7 HRT (Results with study Plants)**	
All Data in ppm		**Control (Results without study Plants)**	**Phragmites australis**	**Typha angustata**
COD	13745.87	5885.87	224.77	800
BOD	3338.08	1361.12	35.62	910.84
Total Hardness	406.67	350	166.67	303.33
Sulphate	0.17	N.D	N.D	N.D
Phosphorus	2.18	1.27	0.14	0.69
TDS	4170	2120	1350	1850
TSS	800	500	N.D	N.D
Chloride	405.44	286.97	170.18	325.35
NO3	0.06	0.01	0.01	0.03
NH3-N	1663.2	575.04	10.08	44.8
Organic Nitrogen	21.28	13.07	2.8	12.51

(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 to 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 are found significant at 5% significant level through one-way Analysis of Variance (ANOVA). The values of F at 5% level for ANOVA are 169.75 for COD, 40.18 for BOD and for organic and ammonical Nitrogen the F value are 700.85 and 9.53.

Further 2 tailed Student's t test has been employed to know the better performance of hydrophytes species. The test revealed that *P. australis* is more potent with respect to treating the Pharmaceutical industry effluent. Only pH and D.O were not significantly decreasing by *P. australis*, (t= 3.38 and 9.18). Further, t-test also showed that *P. australis* is found to have more potential to treat Pharmaceutical 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 play a vital role, due to the oxygen diffusion from their roots (hence, D.O were not significantly decreasing) 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 5Litre of effluent was recorded. *T. angustata* treatment was given in the winter season, where daily loss of 3 to 4 Litre was recorded. The % removal for COD, BOD and ammonical and organic nitrogen were 98.36%, 98.93%, 99.39% and 86.84% respectively.

Conclusion

Following conclusion can be drawn by using laboratory scale model, working on local soil, substrate, 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 uptake of pharmaceutical industry effluent as compared to *T. angustata.*

References

1. Borkar and Mahatme, Wastewater Treatment Using Vertical Flow Constructed Wetland, IJES Volume 2, 2011.
2. M. Bali, M. Gueddari and R. Boukchina, Treatment of secondary wastewater effluent by infiltration percolation: Science Direct, 258, 2010, pp 1-4.
3. H. Brix, Use of constructed wetlands in water pollution control: historical development, present status, and future perspectives: Water. Sci. Tech., 30(11), 1994, 209-223.
4. L. Coulibaly, J. kouakou, I. Savane, G. Gourene, Domestic wastewater treatment with a vertical completely drained pilot scale constructed wetland planted with *Amaranthus hybridus*: African journal of biotechnology,7(15), 2008, pp 2656-2664.
5. IWA, Constructed wetlands for pollution control. Processes, performance, design and operation. Scientific and Technical Report 8, 2008, IWA Publishing, London.
6. R. L. Knight, Wildlife habitat and public use benefits of treatment wetlands: Water Sci. Tech.35 (5). 1997, 35-43.
7. Metcalf and Eddy, Wastewater Engg. Treatment, disposal and reuse: 3rd edition, 1991, McGraw –Hill.
8. Patel and Dharaiya, Phytoremediation of Sugar Industry Effluent using Typha angustata and Phragmites australis through Constructed Wetland: International Journal of Chemical, Biological and Physical Sciences. Sec.D: Nov.2013-Jan. 2014, Vol.4.No.1:846-851.
9. Patel and Dharaiya, Manmade Wetland for Wastewater Treatment with Special Emphasis on Design Criteria. International Journal of Scientific Reviews & Chemical Communications. Sci. Revs. Chem. Commun. 3(3). 2013, 150-160.
10. K. R. Reddy and W. F. Debusk,.Growth Characteristics of aquatic macrophytes cultured in nutrient enriched water: Azoiza, Duckweed and Sqivinia: Econ. Bot. (39), 1985, 200-208.
11. UN-Habitat, Constructed wetlands manual, 2008, Nepal, Kathmandu.
12. A. Upadhyay, Aquatic Plants for the wastewater Treatment: Daya Publishing House, 2004, Delhi, India.
13. J. Vymazal, Constructed wetland for Wastewater treatment: A Review, The 12th World Lake Conference: 965-980
14. B. C. Wolverton, Water Hyacinth for Controlling Water Pollution: Asian Publisher, 1981, New Delhi, India.