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Vertical Sub Surface Flow Constructed Vermifilter

Prasad Amit Kumar[1] and Kumar Sumit[2]

[1]Shri Balaji College of Engineering and Technology, Jaipur, Rajasthan
[2]Tirhut College of Agriculture, Dholi, Bihar.

ABSTRACT

Cost effective and eco friendly water treatment process is need of this modern age. The earthworm species like *Eisenia fetida* (Tiger worm), *Perionyx excavatus* (Indian blue worm) and *Eudrilus euginae* (African night crawler) are very efficient in bioremediation and purification of waste water. The gut microbes of earthworm, play an important role in breakdown and detoxification of complex organic materials. Earthworm vermicast is hydrophilic in nature which adsorbs heavy metals and other chemical pollutants from waste water. Earthworm can bio-accumulates, biodegrade or biotransform any toxic chemicals like organic compounds, pesticides, herbicides and heavy metals. Earthworm species like *Eisenia fetida*, *Eisenia terrestris*, *Lumbricus rubellus* and *Allobophora chlorotica* have also been recorded to remove heavy metals (Cd, Pb, Cu, Hg etc), pesticides and lipophilic organic micro pollutants from the wastewater. Several factors which affect the vermifiltration process like hydraulic retention time, bed thickness, number of earthworm individuals, species of earthworm and developmental stages of earthworm etc. Constructed wetlands are the newer concept efficient in removal of BOD, TDS, Nitrogen etc from waste water. Vertical Subsurface flow constructed vermifilter is the combined form of vertical sub surface flow constructed wetland and Vermifilteration system which is much more efficient in removal of pollutant, so there is need of study in this field.

KEYWORDS: Constructed wetland, vermifilteration, Oligochaeta, sludge reduction, biofilteration

Corresponding Author-

Prasad Amit Kumar

Shri Balaji College of Engineering and Technology, Jaipur, Rajasthan
Email: aksaks29@gmail.com

INTRODUCTION

More than 70% of our fresh water bodies are polluted. Nearly 80% of our water supply returns as municipal wastewater in the sewer system as sewage[1,2]. Our country generates nearly 38000 million liter of sewage per day out of which we can treat only about 12000 million liters per day[3]. Sewage carries hazardous chemicals and very high loadings of organic matter referred as BOD (biological oxygen demand) and COD (chemical oxygen demand) and solids (both dissolved and suspended) solids[4]. The urban runoff in general, carries organic load along with several hazardous chemicals which not only spoils the aesthetic sense of the river but at the same time also degrades the aquatic ecosystem.

Due to high establishment and running cost of a sewage treatment plant (STP) the majority of urban centers in developing world dispose urban runoff and sewerage water directly into urban river without any treatments or with partial treatments[2]. Developing countries cannot afford to construct sewage treatment plants in their cities. Conventional effluent treatment systems, such as, mechanical aeration systems, tank digestion and anaerobic facultative ponds, physico-chemical and biological treatment system are very costly and demand space[1].

A large amount of excess activated sludge produced in wastewater purification, if not properly disposed, may cause a potential threat to both the environment and human health [5]. In conventional waste water treatment process sludge management is very challenging. It accounts for up to 60% of total operating cost of waste water treatment plant [6].

In such a scenario, alternatives are needed urgently for treating wastewaters which are low cost, without any significant negative impacts on the environment. There is tremendous need to develop reliable technologies for the treatment of waste water in developing countries. Such treatment systems must fulfill many requirements, such as simple design, use of non–sophisticated Equipment, high treatment efficiency, low excess sludge production and low operating and capital cost[7].

Vermifilter (VF) was widely used to treat the wastewater, and appeared to have high treatment efficiencies, including synchronous stabilization of wastewater and sludge[8]. It can effectively remove BOD, COD, TSS, TDS, Heavy Metals and other organic pollutant from waste water. Vermifiltration may be a competitive method for wastewater treatment in rural area due to cost saving and ecological characteristics[7]. Vertical Subsurface flow Constructed wetland is also very effective in removing pollutant of waste water. The combination of both Vertical Subsurface flow Constructed Wetland and Vermifilter is named here as “Vertical Subsurface flow Constructed Vermifilter”.

REVIEW OF LITERATURE

Constructed wetlands are defined as those wetlands which are specifically constructed for treating wastewater and are effective in the removal of BOD, TSS, and nitrogen[8]. Typically there are three types of constructed wetlands[9]. The first is called free-water surface wetlands (FWS), in which the water surface is exposed to the atmosphere. The second and the third can be grouped into the subsurface-flow types (SFCWs), in which the difference lies mainly on the feeding pattern, either vertically- (VSFCWs) or horizontally-fed (HSFCWs). VSFCWs are characterized by an intermittent (discontinuous) feeding where wastewater vertically percolates through a substrate layer that mainly consists of sand, gravel or a mix of these[10].

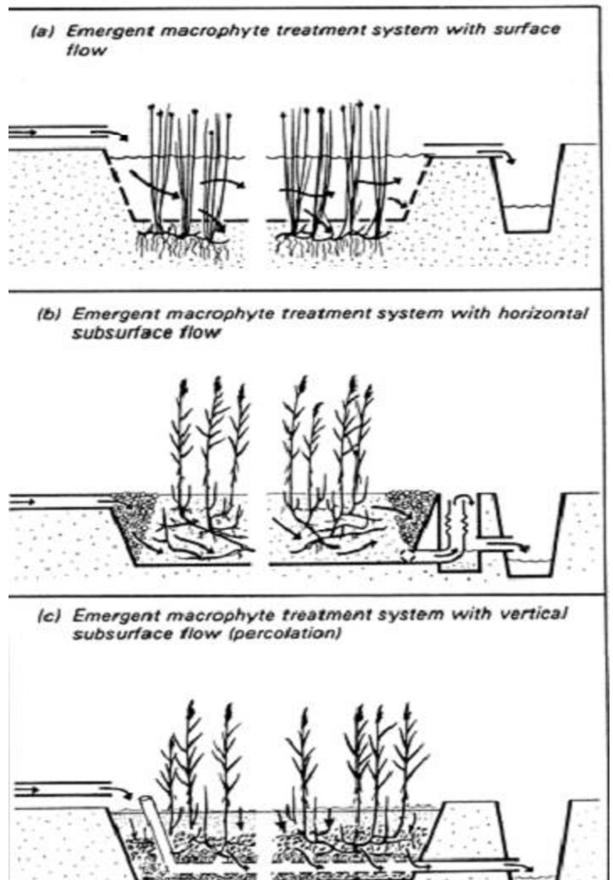

Fig. No. 1 : Three types of Constructed wetland[10]

On-site treatment of waste water is a decentralized modality for waste water treatment that requires only simple, low-cost, reliable, energy-efficient technology. As such It can be conducted by private home owners without special skills or training. Vermifiltration is the process which can handle this problem[9]. Vermifiltration technology possesses the capacity to process organically polluted water, It break down a wide range of organic materials[11] *Eisenia fetida* (tiger worm), *Eisenia andrei* (red tiger worm), *Perionyx excavatus* (indian blue), *Eudrilus eugeniae* (African nightcrawler) and *Eisenia veneta* (European nightcrawler) are the species widely used in vermifiltration process

The treatment efficiency was not influenced only by earthworm abundance but also the earthworm growth state[9]. In ensuring an efficient treatment system, sufficient density of earthworms and good vermifilter conditions are necessary for earthworm growth in suitable hydraulic loading rates.

There are various studies are available on vermifiltration, vermi-biofiltration or only constructed wetland filtration system for removal of pollutant/nutrients from waste water[2]. Very few reports are available on combined vermi-biofiltration and constructed wetland system, for waste water treatment. In 2010 Chiarwatchi has worked on combined vertical sub-surface flow constructed wetland ($VSFCW_S$) with earthworms[10]. Again in 2011 P.Tomar and S.Suthar worked on an integrated vermi-biofiltration system with $VSFCW_S$[2]. These combined system is cost effective and sustainable option for waste water treatment.

Priyanka Tomar and Surindra Suthar (2011) constructed wetland ($VSFCW_S$) with earthworms by using a wetland weed Cyprus rotundus and live biomass of a local earthworm P. sansibaricus) in treatment of urban wastewater. This design is a cost effective and sustainable option for onsite wastewater treatment. Results clearly suggested that integrated vermi-biofiltration reactor was more efficient than traditional biofiltration system in terms of removal of key chemical pollutant from wastewater (Fig. 9). Although, results clearly indicates the efficacy of vermibiofiltration system in wastewater treatment but further detailed studies are still required to answer few key issues of this system, e.g. hydrolic load, retention time impact, microbial ecology in vermibeds, earthworm-microbial interaction etc.

POLLUTANT REMOVAL MECHANISM

Table No. 1: Pollutant Removal Mechanism[10]

Constituent	Removal Mechanism
Biodegradable organics	Bioconversion by facultative and anaerobic bacteria on plant and debris surfaces
Suspended solids	Filtration, sedimentation
Nitrogen	Nitrification/denitrification, plant uptake, volatilization
Phosphorus	Filtration, sedimentation, plant uptake
Heavy metals	Adsorption of plant roots and debris surfaces, sedimentation
Trace organics	Adsorption, biodegradation
Pathogens	Natural decay, physical entrapment, filtration, predation, sedimentation, excretion of antibiotics from roots of plants

FUTURE PROSPECTUS

This work can be implemented in Industrial waste water treatment in the coming future in large scale. Industries like food, tannery, textile etc produce waste water with biodegradable waste which can be consumed by earthworm easily. These Industries invest a huge amount of money for waste management that can be saved by this method.

This method of waste water treatment is cost effective, eco friendly and is sufficient enough to satisfy the water quality parameter set by government of India; hence there is need of study in large scale so that it can be easily implemented in other industries.

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REFERENCE

1. Tengku Erina Binti, U A. Malek, S. A Ismail and M. H. Ibrahim. A study on hydraulic loading rate and worm density in vermifiltration of Palm Oil Mill Effluent. Journal of Industrial Research and Technology,2013; 3(1): 1-5.
2. Priyanka Tomar, Surindra Suthar. Urban Waste water treatment using vermin-biofiltration system. Desalination. October 2011; 282: 95-103.
3. CPCB. Status of water supply, wastewater generation and treatment in class-I cities & class-II towns of India. Central Pollution Control Board. 2009.
4. Sharma S. K., Gupta Pankaj, Borauh Monalisa and Usmani Nisar Khan, A Hydro Biochemical studies of fluoride concentration on human beings. International Journal of Scientific Research and Reviews June 2012 ; 1 (1): 67-72.
5. Y.S. Wei, H. Zhu, Y.W. Wang, J.F. Li, P.X. Zhang, J. Hu, J.X. Liu. Nutrients release and phosphorus distribution during oligochaetes predation on activated sludge. Biochem. Eng. 2009; 43: 239–245.

6. Wei, Y.S., VanHouten, R.T., Borger, A.R., Eikelboom, D.H., Fan, Y.B. Minimization of excess sludge production for biological wastewater treatment. Water Res. 2003; 37: 4453–4467.
7. Su Wang, Jian Yang, Shan-Jie Lou, Jian Yang. Wastewater treatment performance of a vermifilter enhancement by a converter slag–coal cinder filter. Ecological Engineering. 2010; 36: 489-494.
8. Meiyan Xing, Xiaowei Li, Jian Yang, Baoyi Lv, Yongsen Lu Performance and mechanism of vermifiltration system for liquid-state sewage sludge treatment using molecular and stable isotopic techniques. Chemical Engineering Journal. 2012; 197; 143-150.
9. XING Meiyan, Yu Fen, LIU Jing, YANG Jian. Vermifiltration as a final-stage process for rural sewage purification in China. State Key Laboratory of Pollution Control and Resources Reuse. College of Environmental Science and Engineering. Tongji University Shanghai ISBN IEEE. 2010; 978-1-4244-4713-8/10/25.
10. N. Chiarawatchai. Implementation of earthworm-assisted constructed wetlands to treat wastewater and possibility of using alternative plants in constructed wetlands. Ph.D. Thesis. Hamburg University of Technology. 21073 Hamburg, Germany 2010; 105.
11. Kwon, Y.T., Lee, C.W., Yun, J.H. Development of vermicast from sludge and powdered oyster shell. J. Clean Prod. 2009; 17: 708-711.
12. Rajiv K. Sinha, G. Bharambe, U. Chaudhari. Sewage treatment by vermifiltration with synchronous treatment of sludge by earthworms: a low-cost sustainable technology over conventional systems with potential for decentralization. Environmentalist. April 2008; 28: 409–420