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Sewage Treatment by Vermifiltration

Neha V.Sonawane[1], Akanksha V. Pisolkar and Dr. Ashok L. Varne

[1] *Assistant Professor,K.K.Wagh Institute of Engineering Education and Research, Nashik,Department of Civil Engineering, Maharashtra, India.*

[2] *Assistant Professor ,K.K.Wagh Institute of Engineering Education and Research, Nashik,Department of Civil Engineering, Maharashtra, India.*

[3] *Associate Professor, K.K.Wagh Institute of Engineering Education and Research, Nashik, Department of Civil Engineering, Maharashtra, India.*

[a]*nv.sonawane@kkwagh.edu.in*, [b]*avpisolkar@kkwagh.edu.in*, [c]*alvarne@kkwagh.edu.in*

Abstract

Wastewater treatment is the traditional method that is used to remove contaminants from wastewater before discharge into inland waterways. It provides one of the most promising ways to overcome the global water crisis. The conventional treatment methods are costly in the view of installation, operation and maintenance. With the consideration of the present shift towards sustainable development, use of eco-friendly material for treatment, slows down the negative impact on the environment. Among all the existing methods of wastewater treatment vermifiltration is the sustainable choice. The vermifiltration is the bio filter with earthworms; degrade organic matter through process of ingestion and enzyme activity. In the present study the efficiency of vermifiltration is determined by considering the parameters such as pH, BOD, COD, TDS, Turbidity and outcomes are compared with permissible standard of treated water. This technique provides good quality of treated water and nutrient enriched bi-product like vermicomposting.

Keywords: *Earthworms, Filter Media, Vermifiltration, Vermiculture, Wastewater parameters*

Introduction

Nowadays, the world is facing the problem of water scarcity due to tremendously increased depletion, contamination, societal demands and drought of existing water re- sources [4]. One of the alternatives for urban and rural areas is vermifilters (VFs) and now this system is adopted in many developing countries [2]. Vermifiltration using earthworms is naturally acceptable, self-enhanced, technically sustainable, self-enhanced, low-cost and bio-safe technology that uses earth- worms for domestic and industrial wastewater treatment [5]. Many previous studies on vermifiltration investigated the treatment efficiency, Nutrient and pollutants removal efficiency of industrial and domestic wastewater and stabilized the effect of wastewater treatment by VFs [2,3,5]. These studies mostly focused on the organic loading rate, hydraulic loading rate [8], and effects of filter media [11]. Literature showed that vermicomposting depend upon the relationship between earthworms and microorganisms, in which microbes perform degradation of organic waste material, while earthworms degrade and homogenize the material through muscular actions of their foregut and add mucus to the ingested material, thereby increasing the surface area for microbial action [1,6] It is the promising alternative technology for decentralized wastewater treatment. Compared to centralized systems, vermitechnology provides many benefits like low operational cost, low installation cost and combined treatment of wastewater and solid waste. In vermifiltration, body of earthworms work as a biofilter, and they have been found to remove the , total suspended solids (TSS), total dissolved solid (TDS),biochemical oxygen demand (BOD) and chemical oxygen demand (COD) by 80–90% from wastewater and also by their adsorption through skin [2,8]. Reported that earthworm technology showed efficient reduction of suspended solids, BOD_5, NH_3-N and COD despite the fluctuations of hydraulic loading rate (HLR) and organic input. Previous researches proved that this technology is one of the sustainable technologies such as vermifiltration for wastewater treatment and vermicomposting for solid waste disposal for reuse in irrigation purposes. Most of the researchers used *E. fetida* for vermicomposting and vermifiltration purposes [8, 9, 10]. Therefore, the present study aims

1. To study the performance of different types of earthworm like dragon and tiger for filtration of domestic wastewater.
2. To prepare a working model of filtration using dragon earthworm.
3. To study physico-chemical properties of wastewater.
4. To provide an economical solution for utilization of wastewater by considering cost analysis.

Materials and Methodology

1. Earthworm- Earthworm is a tubular, segmented worm of the phylum Annelida. An earthworm's digestive system is based on its body length.

Fig.1 Earthworm

2. Vermiculture- It is the eco-friendly fertilizer which is made up of the process of decomposition of natural materials such as biodegradable organic material using various species of worm, usually red wigglers, white worms, and other earthworms.

Fig. 2 Vermiculture

3. Wastewater sample- Wastewater samples are collected from residential areas and small scale industrial areas. For these samples pH range is 6-7.5mg, BOD range 350-700 mg/lit, COD 250-400 mg/lit, TDS range 300-400 ppm, Turbidity range 250-350 NTU, TSS range 350-450 ppm. All these values are greater than its permissible limits.

4. Aggregate and sand- Filtration layers are added according to standard specification. Bottom layer is of coarse aggregate having size 10-12mm, middle layer is of fine aggregate having size 4-6 mm and top layer is of sand having size 1-2mm.

Methodology

Fig. 3 shows pilot scale model of size 40x40x60 cm having four layers of filtration bed. Topmost layer is an organic fraction of municipal solid waste of 12 cm thickness. Second layer is of vermigratings of 12 cm thickness. Third layer is of sand of 12 cm thickness. The Fourth layer is of fine aggregate of 12 cm thickness and the last layer is of coarse aggregate of 12 cm thickness.

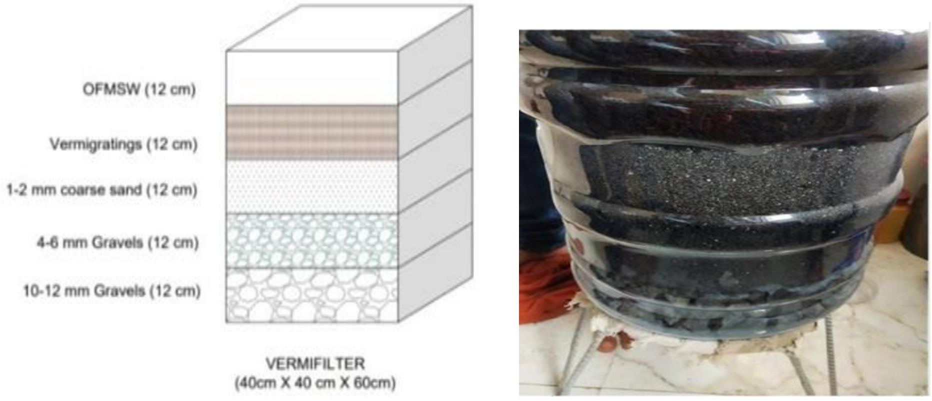

Fig. 3 Pilot Scale vermifiltration model

Wastewater passes through filter beds where organic material adsorbed into the surface and degraded by active participation of earthworms is converted into nutrient enriched vermicomposting by the earthworm. This is followed by filtration through filter beds. Filter media supports the growth of microorganisms which occur in secondary treatment units. Dissolved and suspended particles are arrested in the filter media as they percolate and stabilize in the filter media. Earthworms help to improve aeration as they accelerate microbial activity by increasing the population of microorganisms. This helps to avoid clogging in vermifilter.

Result and discussion

This section summarizes each laboratory parameter, followed by an appropriate discussion on the current study.

Parameter	Synthetic sample 1		Synthetic Sample -2		Removal Efficiency (%)
	Influent	Effluent	Influent	Effluent	
pH	6.7	7.2	7.4	7..1	-
TSS	390	28	430	35	87-89
TDS	350	25	320	22	75-85
COD	250	60	310	50	70-75
BOD	390	81	670	95	85-90

A. pH

This influent had a pH of 6.5-7.5 which is almost neutral. Treated wastewater having pH value is around 7-7.5. Considering that the culture is suitable for earthworms and that the pH of influent and effluent wastewater is not too acidic or alkaline. Wastewater effluent is not harsh, making the suitable conditions for the earthworms to perform efficiently in the vermifiltration.

B. Total Suspended Solids (TSS) and Total Dissolved solids (TDS)

Around 75-90 % of TSS and TDS particles were removed from the process of vermifiltration. The filtration media such as coarse aggregate, fine aggregate and sand help to remove suspended particles and the vermiculture helps to remove dissolved solids inside their media. Breakdown of organic matter takes place by earthworms and microorganisms and produces stabilized matter of minute size.

C. Biochemical Oxygen demand (BOD)

The results show that the earthworms give around 85-90 % of BOD removal than Infflluent value or nearly complete at hydraulic retention time (HRT) of 2-3 hr. The earthworms help to degrade organic matter present in wastewater by ‘enzymatic actions’ and this is the reason for higher reduction in BOD value.

D. Chemical Oxygen Demand (COD)

The result shows COD removal is to be around 70-75 % considering the permissible limits according to the Central Pollution Control Board. However, the rate of BOD removal is higher than the rate of COD removal by 10-12 %. It concluded that the earthworms were unable to reduce the inorganic content in the wastewater since they are totally dependent on the organic matter in the wastewater. This may be due to the earthworm's adsorption capacity, which allows them to stick and survive on the organic matter more firmly for proper decomposition.

Conclusion

The vermifiltration results show that the average final effluent and removal efficiencies of COD, BOD, TDS, and TSS are in a range of 69-70%, 85-90% 75-85% and 87-89% respectively. It has been found that during hydraulic retention time the population of earthworms is increased. Vermifiltration technology is odour free, efficient and economical. It is proven to be an effective method for treating waste water in a decentralized manner.

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