

Application of Vermifiltration in Domestic Wastewater Treatment

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ABSTRACT: Vermifiltration is a treatment method that combines the conventional filtration processes with the vermicomposting techniques. It has opened new grounds for treating wastewater in the world, and especially so in the developing countries due to its low cost and eco-friendly nature. Research is on-going in this area since the field has gained attention from the scientific community only recently.

Vermifiltration was used for the treatment of domestic wastewater using *Eudriluseugeniae* earthworm species. Earthworms' body works as a 'biofilter' and found to remove organic loadings present in the wastewater. Domestic wastewater treatment using earthworms is found to be more effective compared to treatment without worms. Chemical Oxygen Demand (COD) and Chlorides present in domestic wastewater found to decrease about 57-66% and 70-77% for 2hr, 4hr and 6hr H.R.T respectively. Hence vermifiltration technique is an efficient, odourless process and the resulting vermifiltered water is clean and disinfected enough to be reused for farm irrigation and in parks and gardens.

KEYWORDS: Vermifiltration, Organic loadings, Odour-free process, Hydraulic loading rate.

I. INTRODUCTION

Nearly 80% of the water supply used by the society returns as domestic wastewater in the sewer system as sewage. Sewage carries hazardous chemicals and high loadings of organic matter referred as BOD (biological oxygen demand) and COD (chemical oxygen demand) and solids which include both dissolved and suspended solids. Sewage has to be treated to reduce the organic loads before discharging into environment (rivers and oceans) or else the aerobic bacteria there will consume more dissolved oxygen (DO) from river/ocean water to decompose organic materials thereby depleting the DO values. This would seriously affect the survival of all aquatic organisms in the rivers and oceans.

Vermifiltration of wastewater using waste eater earthworms is a newly conceived novel technology. Earthworms' body works as a 'biofilter' and they have been found to remove the 5 days' BOD₅ by over 90%, COD by 80-90%, total dissolved solids (TDS) by 90-92%, and the total suspended solids (TSS) by 90-95% from wastewater by general mechanism of 'ingestion' and biodegradation of organic wastes, heavy metals and solids from wastewater and also by their 'adsorption' through body walls [1].

There is no sludge formation in the process which requires additional expenditure on landfill disposal. Earthworms increase the hydraulic conductivity and natural aeration of the organic particles by granulating the organic particles into small particles [2].

Vermifiltration is a low-cost, odourless and non-labour intensive method of wastewater treatment. Also by their grinding action, the total specific area of the filter bed is increased by the earthworms, which in turn increases the adsorption capacity. The mechanisms like microbial stimulation, biodegradation and enzymatic degradation of waste materials work simultaneously in vermifiltration system [3].

Earthworms promise to provide cheaper solutions to several social, economic and environmental problems plaguing the human society. Earthworms can safely manage all municipal and industrial organic wastes including sewage sludge and divert them from ending up in the landfills. Their body work as a 'biofilter' and they can 'purify' and also disinfect and detoxify municipal and several industrial wastewater. They reduce the BOD & COD loads and

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the TDSS of wastewater significantly. They can even remove the EDCs (endocrine disrupting chemicals) from sewage which is not removed by the conventional sewage treatment plants. Earthworms can bio-accumulate and bio-transform many chemical contaminants including heavy metals and organic pollutants in soil and clean-up the contaminated lands for development. Earthworms restore & improve soil fertility by their secretions (growth hormones) and excreta (vermicast with beneficial soil microbes) & boost 'crop productivity'. They have potential to replace the environmentally destructive chemical fertilizers from farm production. The 'protein rich' earthworm biomass is being used for production of 'nutritive feed materials' for fishery, dairy & poultry industries. They are also being used as 'raw materials' for rubber, lubricant and detergent industries. The bioactive compounds isolated from earthworms are finding new uses in production of 'life saving medicines' for cardiovascular diseases and cancer cure [4].

II. RELATED WORK

Sinha et al (2008) reported that body of the earthworms works as a 'biofilter' and they are found to remove the 5 days BOD (BOD_5) by over 90%, COD by 80–90%, total dissolved solids (TDS) by 90–92%, and the total suspended solids (TSS) by 90–95% from wastewater by the mechanism of 'ingestion' and biodegradation of organic wastes, heavy metals, and solids from wastewater and 'absorption' through their body walls. Ghatnekar et al (2010) studied to convert secondary liquid effluents from gelatine manufacturing industry into detoxified water, three-tier vermiculture biotechnology coupled with vermifiltration is used. Using the combination of protease and cellulose, the pre-treatment is done. There was remarkable reduction of COD and BOD in resulting vermi-filtered water by 90.08% and by 89.24% respectively.

III. MATERIALS AND METHODOLOGY

The domestic wastewater sample was collected from HKR Circle, Nituvalli Davangere in Karnataka. *Eudriluseugeniae* earthworm species commonly called African Night Crawler were used in the study. The species were collected from Tharalubalu Krishi Vignan Kendra of Davanagere in Karnataka. The study was carried out in a vermi-filtration kit of size 0.45m x 0.45m x 0.75m. The vermi-filtration kit contains a layer of sand and gravel with layer of garden soil on top. Provisions to collect the filtered water are made at the bottom through a pipe. The bottom most layer is made of gravel aggregates of size 20mm and above this there is a layer of gravel of size 10mm and top layer consists of gravel of size less than 10mm. These gravel layer fills up to a depth of 21cm each of size 7cm depth. Sand layer of depth 10cm is kept at the top of the vermifilter. The topmost layer of 20cm depth consists of garden soil, where the earthworms were released (Vermifilter kit) [5]; as per in Figure (a).

The domestic wastewater is made to pass through beds of vermifilter under gravity. Hydraulic Retention Time of 2hr, 4hr and 6hr is maintained respectively; the discharge was maintained manually.

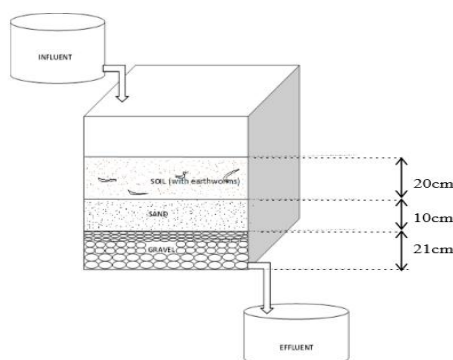


Figure (a): Schematic diagram of Vermifiltration kit

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IV. RESULTS AND DISCUSSIONS

The parameters of domestic wastewater like chlorides and COD were analysed and results are as below:

Parameters	Influent (same for 3 cycles)(mg/l)	Effluent					
		2hr	%Removal	4hr	%Removal	6hr	%Removal
Chlorides	195	60.5	68.9	50	74.35	44.6	77.12
COD	240	101.5	57.7	90.33	63.36	81.8	65.91

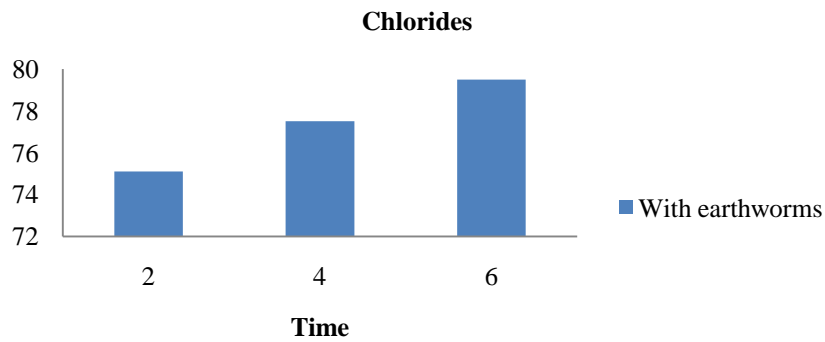


Fig (b): Percentage Reduction in Chlorides using Vermifiltration technology

Initial chloride was found to 195 mg/L, it was reduced to 69%, 74% and 77% for 2hr, 4hr and 6hr respectively. As Hydraulic loading rate increases, the removal efficiency also increases.

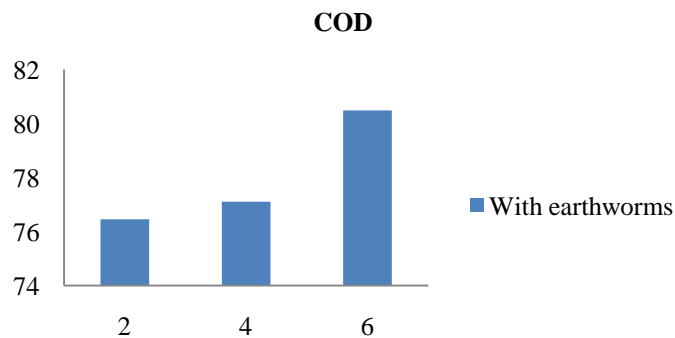


Fig (c): Percentage Reduction in COD using Vermifiltration technology

Initial chloride was found to 195 mg/L, it was reduced to 57%, 63% and 66% for 2hr, 4hr and 6hr respectively. As Hydraulic loading rate increases, the removal efficiency also increases.

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V. CONCLUSIONS

The following are the conclusions made from the experimental study:

- Vermifiltration is a logical extension of 'soil filtration' and can be a most cost-effective and odour free process for sewage treatment with efficiency.
- On an average vermifilter removed chlorides and COD for about 70-77% and 57-66% respectively.
- It is found that as H.R.T and number of earthworms' increases; the removal efficiency also increases.

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