Performance Evaluation of Laboratory Scale Vegetated Vermifilter for Domestic Wastewater: Case Study of Kolhapur

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Abstract -
Earthworm bodies have been shown to act as biofilters and remove BOD, COD, TDS, and TSS through common mechanisms of uptake, biodegradation, and absorption from the body wall. Two laboratory-scale vertical vermifilters will be developed. One uses only canna indica and filter media, and the other uses canna indica and (earthworms) with the filter media. The experimental phase will last 72 hours. Various parameters such as BOD, COD, pH, turbidity, canna indica growth, bed clogging. Organic waste management is increasingly concerned due to unsustainable disposal practices. Sewage treatment facilities are designed to treat wastewater in a way that produces safe wastewater. However, one of the by-products, sewage sludge, is rich in pathogens because it is disposed of in landfills and used as fertilizer on farms. Sustainability can be achieved by composting organic matter with vermi. This includes accelerating nutrient circulation through a closed-loop system, leading waste to productive end applications. Earthworm composting and worm filtration are natural waste management processes that rely on the use of worms to convert organic waste into stable soil concentrates. We investigated the fate of filter materials and microbial communities during the vermifiltering process for a month while treating concentrated miscellaneous wastewater. Two filters are filled with 10 cm, the first layer from the bottom is coarse aggregate (size 20 mm, height 6 mm), the second layer is (size 10 mm, height 4 mm), and the third layer is charcoal (size). 25mm, height 4mm), 4th layer is sand (size 4mm, height 4mm), 5th layer is soil, last layer is freeboard.

***Key Words*:**Domestic Wastewater, Vermifilter, COD, BOD, Canna Indica, Eisenia Fetida.

1. INTRODUCTION:

According to UNICEF, an estimated 564 million people defecate in India, which is almost half of the world's population. According to the latest Indian Census, 49.84% of people practice open turf, while 47% of Indian households have a household toilet. Most Indian cities are only partially drained. A whopping 48% of urban households in India rely on on-site facilities (mainly septic tanks and pit latrines) to meet their hygiene needs. This reliance on on-site hygiene naturally increases with rapid population growth and urbanization. Therefore, at the national level, it is clear to focus on a sustainable service delivery approach to hygiene. Indian cities often face the challenge of connecting suburbs and underdeveloped parts of the city to existing sanitation systems (such as sewage treatment facilities). In such cases, the decentralized treatment approach is a logical solution. In this system, wastewater is treated at or near a water source and rather than being connected to a centralized sewage system, a relatively small amount is discharged from a single house to the entire community nearby. This system offers the advantage of recycling and reusing wastewater in that particular area. The current take-make-up-disposal approach can be counteracted by this system, which complements the concept of "circular economy". The amount of miscellaneous wastewater produced at home varies greatly from about 15 liters per person per day in poor households to 100 liters per person per day. Of the 100%, 25% is black water, 75% is reclaimed water, and can rise to 90% in drywall. Reclaimed water accounts for 69% of domestic wastewater. To recycle and reuse such a large amount of wastewater, treatment options should be considered. One such solution is decentralized processing, which allows the community to focus on the most pressing processing needs, while allowing smaller design flows and waste areas. As a result, the financial burden is concentrated on individual properties rather than the entire district. For rural or remote residential or community applications, decentralized systems have many advantages, and the appropriate approach varies from case to case. Officials and residents need to be aware of the current problems and flaws in the community's wastewater treatment system. Areas that may include obsolete or non-existent sewer systems, sewer leak and overcapacity systems, sewer overflows, lack of funds, watershed problems, groundwater pollution, sensitive nutrient overloads, And / or violation of regulations. Vermifilter is a new distributed treatment option to consider.

In addition to the gravel and sand media used in traditional wastewater treatment filters, worms form vermifilters. Also known as lumbrifilter Filter or Vermi-digester. About 80% of the water used by society is discharged into the sewer as urban sewage. Wastewater contains very high levels of organic matter (BOD) and COD (Chemical Oxygen Demand) and solids in dissolution and suspension, in addition to toxic compounds. Wastewater must be treated to minimize the load of organic matter before it is discharged into the environment (rivers and oceans). Otherwise, aerobic bacteria use a lot of dissolved oxygen (DO) from rivers and seawater to digest organic matter and lower DO levels. I lowered it. This will jeopardize the survival of all aquatic species in rivers and oceans. Wastewater vermifiltering with garbage-eating earthworms is an innovative technology that has just been developed. The general mechanism of "uptake" and biodegradation of organic waste, heavy metals and solids from wastewater by earthworms is to reduce BOD (BOD5) for 5 days by more than 90% and COD by 80-90%. It has been found to remove all dissolved solids (TDS from wastewater due to the general mechanism of "uptake" and biodegradation of solids from organic waste, heavy metals and wastewater and their "absorption"). Increases 90-92% and total suspended solids (TSS) by 90-95%. 'Through the body wall. Since there is no sludge, no additional landfill costs are required. This process is also odourless and the resulting vermilion filtered water can be safely used for agricultural irrigation, parks and gardens. These drilling processes create aerobic conditions in the waste and prevent anaerobic microorganisms from releasing the foul-smelling hydrogen sulfide and mercaptans. Many poor countries cannot afford to build and operate expensive sewage treatment facilities. You need a cheaper alternative to wastewater treatment. As demand continues to grow, centralized wastewater treatment systems may not be able to meet the needs of future sustainable wastewater management in both developed and developing countries, at least for new developments. Individual households or groups of households can treat household wastewater at the source, reducing the load (BOD and COD load) on the sewage treatment plant (STP) further downstream of the sewage system.

2. METHODOLOGY

***A.EXPERIMENTAL SETUP**:*

The experimental equipment consists of two glass reactors installed in the laboratory. The filter bed should be filled with 5 layers (top to bottom). The top layer or worm active layer consisted of 1: 3 volume ratio vermicompost and garden soil. The second layer from the top is considered wash sand, 10 mm fine gravel and 20 mm coarse gravel, respectively. The full investigation is expected to be completed over 72 hours and both reactors will be provided with a 15-day acclimation period prior to analysis.

B.*PREPARATION BED:*

a) After designing the laboratory-scale model, 10 mm thick glass was selected to manufacture the reactor.

b) Glass was selected for aesthetic reasons only and did not affect the actual process.

c) A local fish tanker was tasked with building a 1 foot x 1 foot x 2 foot reactor. The reactor inlet has a 1 foot x 1 foot hole on one side to accommodate the inflowing water.

d) An outlet was excavated in the reactor and a faucet was installed to take a sample of wastewater.

e) Thorough sieving analysis was performed to separate sand debris by size. size.

f) The reactor was divided into 6 parts of 10 cm each. It was filled with soil of various sizes from top to bottom in ascending order from about 6 mm to 12 mm.

g) The top layer of 10 cm was considered freeboard, followed by soil less than 6 in size. mm.

3. RESULTS AND DISCUSSION: Various analyses are performed using inflows and outflows to understand the physicochemical and biological properties. MAVF (Macrophyte Assisted Vermi filter) has been found to be more efficient than other designed MAFs (Marcrophyte Assisted Filters) due to its extremely low odour, colour and turbidity.

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(1) (2)

Figure 1:(1) Fabricated Lab-Scale Model

(2) Canna Indica Species

[3] [4]

[5]

Figure 2: (1) free bord

(2) Second layer of model

(3) Third layer of model

(4) Fourth layer of model

(5) Fifth layer of model

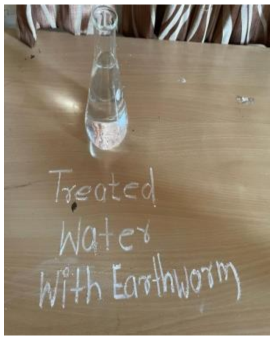

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Figure 3:(1) Treated water with earthworms

(2) Treated water without earthworms

(3) Domestic wastewater

BOD Results:

BOD	1st filling	2nd filling	3rd filling	4th filling	5th filling	6th filling	7th filling
Influent	128	135	132	120	125	127	130
72 Hours MAVF	56	58	52	48	35	31	32
72 HOURS MAF	74	68	71	72	65	59	56

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BOD	9th filling	10th filling	11th filling	12th filling	13th filling	14th filling	15th filling
Influent	121	126	135	138	137	131	129
72 Hours MAVF	28	25	21	22	23	21	23
72 HOURS MAF	51	53	53	49	50	49	45

COD Results:

COD	1st filling	2nd filling	3rd filling	4th filling	5th filling	6th filling	7th filling
Influent	305	285	295	298	275	289	301
72 Hours MAVF	135	142	145	138	118	95	97
72 HOURS MAF	158	162	165	159	148	135	132

COD	9th filling	10th filling	11th filling	12th filling	13th filling	14th filling	15th filling
Influent	292	289	287	279	282	294	298
72 Hours MAVF	98	91	92	94	89	102	99
72 HOURS MAF	125	129	132	131	133	139	132

TURBIDITY Results:

Turbidity	1st filling	2nd filling	3rd filling	4th filling	5th filling	6th filling	7th filling	8th filling
Influent	158	165	178	154	185	160	165	164
72 Hours MAVF	45	47	41	38	21	22.7	20.9	22.5
72 Hours MAVF	47	51	39	32	21	21.5	21	22.5

COD	9th filling	10th filling	11th filling	12th filling	13th filling	14th filling	15th filling
Influent	170	172	168	159	160	163	167
72 Hours MAVF	19.6	18.4	19	21.8	18.5	19	21
72 HOURS MAF	20	19	21	20.5	19	20.5	18.5

pH Results:

pH	1st filling	2nd filling	3rd filling	4th filling	5th filling	6th filling	7th filling	8th filling
Influent	7.89	8.1	7.9	8.0	8.1	7.5	7.89	7.9
72 Hours MAVF	7.69	7.8	7.778	7.65	7.4	6.9	7.1	7.21
72 HOURS MAF	7.8	7.81	7.56	7.45	7.31	7.0	7.1	7.25

pH	9th filling	10th filling	11th filling	12th filling	13th filling	14th filling	15th filling
Influent	7.6	7.5	7.6	7.45	7.9	7.85	7.65
72 Hours MAVF	6.9	6.98	7.12	7.1	7.0	7.2	7.1
72 HOURS MAF	7.1	7.2	7.25	7.2	7.11	7.25	7.12

4. CONCLUSIONS:

• MAVF has a much better therapeutic effect than MAF, suggesting that the integrated approach is more effective and lasting.
• Due to the symbiotic and synergistic activity of earthworms and plants, no MAVF clogging was observed throughout the operation period.
• Almost no inundation was observed at the MAF at the end of the treatment period. This may be due to a lack of earthworms.

Earthworm tunneling in the filter bed aerminates the substrate, allows water, nutrients, oxygen and microorganisms to pass through, increasing the performance efficiency of MAVF. Large plant-assisted vermifilter (MAVF) systems reduce BOD and COD in domestic wastewater by 70-80% and can be used as an effective and alternative method for a variety of distributed wastewater treatment systems.

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