Vermi-Filtration On Waste Water

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Abstract- *Nearly 80% of the water supply used by society returns as municipal wastewater in the sewer system as sewage. 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.A vermifilter (also vermi-digester or lumbrifilter) is an aerobic treatment system, consisting of a biological reactor containing media that filters organic material from wastewater. The media also provides a habitat for aerobic bacteria and composting earthworms that purify the wastewater by removing pathogens and oxygen demand. The "trickling action" of the wastewater through the media dissolves oxygen into the wastewater, ensuring the treatment environment is aerobic for rapid decomposition of organic substances.*

Keywords- passive treatment, earthworms, vermiculture, vermi-digester

I. INTRODUCTION

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' BOD (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 the general mechanism of 'ingestion' and biodegradation of organic wastes, heavy metals, and solids from wastewater and also by their 'absorption' through body walls. There is no sludge formation in the process which requires additional expenditure on landfill disposal. This is also an odor-free process and the resulting vermifiltered water is clean enough to be reused for farm irrigation and in parks and gardens. They create aerobic conditions in the waste materials by their burrowing actions, inhibiting the action of anaerobic microorganisms.

II. MATERIALS USED

2.1 EARTHWORM:

Earthworm species used Long-term researches into vermiculture have indicated that the Tiger Worm (Eisenia fetida), Red Tiger Worm (E. andrei), the Indian Blue Worm (Perionyx excavatus), the African Night Crawler (Eudriluseuginae),and the Red Worm (Lumbricusrubellus) are best suited for vermitreatment of variety of solid and liquid organic wastes under all climatic conditions (Graff 1981). Eisenia fetida and E. andrei are closely related. An army of the above five species combined together works meticulously.

Previous studies have primarily focused on the use of vermifilter or its combined processes in the treatment of different types of wastewater, and the related factors contributing to its efficiency in removing pollutants. However, neither study has focused on the Vermifiltration on continuous mode of operation and the capacity of earthworms to treat the wastewater.

Our study has indicated that E. fetida(vermicomposting of both domestic and industrial organic waste), E.Andrei are voracious waste eaters and biodegraders. We used mixture of these two species in our experiment and it shown in Fig.1

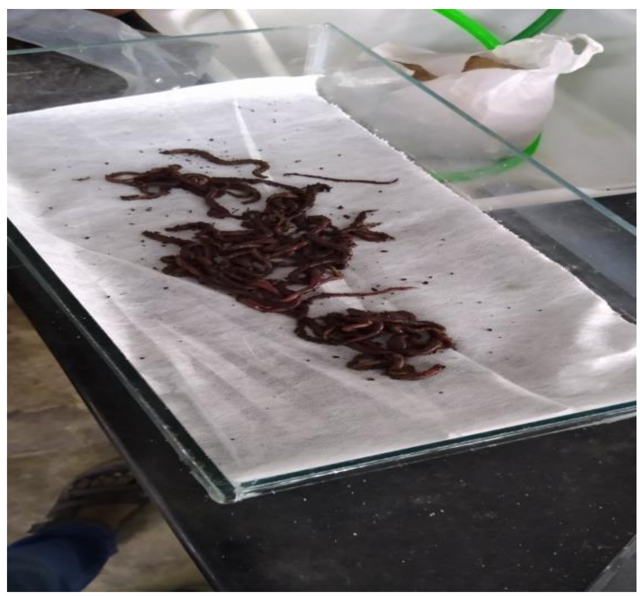


Fig.1 Species of earthworms (Eisenia fetida&E. Andrei)

2.2 AGGREGATE:

Aggregate are chemically inactive and as only filler material and it should be free from grass and clay content should not exceed 4%.Our study has indicated that we used three layers of different sized aggregate and is represented as Fig.2

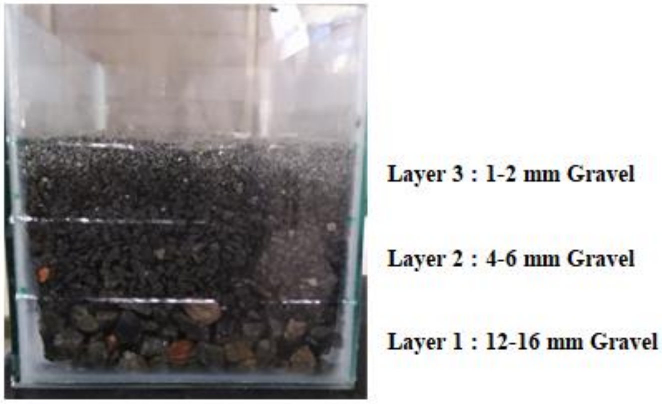


Fig.2 Different sized gravel in different layer

2.3 GEOTEXTILE FABRIC SHEET:

Geotextiles are permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain. Geotextile composites have been introduced and products such as geogrids and meshes have been developed. Non-woven geotextiles resemble felt and provide planar water flow. They are commonly known as filter fabrics, although woven monofilament geotextiles can also be referred to as filter fabrics. Typical applications for non-woven geotextiles include aggregate drains, asphalt pavement overlays and erosion control.

Our study indicates that we use non woven geo textile fabric sheets shown as Fig.3 , that the function to drain the water and prevent entry of sludge into filler material.

Fig.3 Non Woven Geotextile Fabric sheets

III. DETERMINATION OF HYDRAULIC LOADING RATE

Hydraulic loading rate can be calculated by:
HLR = V waste water / A x t
V waste water = Volumetric flow rate of wastewater (m3)
A = Area of soil profile exposed (m2)
t = 1hr
HLR =0.185/(20x37x10^{-4}x1)
HLR =2.5 hrs
Therefore the hydraulic loading rate of water be as 2.5 hrs.

3.1 CRITICAL FACTORS AFFECTING VERMIFILTRATION OF SEWAGE

Hydraulic Retention Time (HRT) and Hydraulic Loading Rate (HLR) are two important factors which affect the treatment and quality of treated wastewater.High hydraulic loading rate leads to reduced hydraulic retention time (HRT) in soil and could reduce the treatment efficiency. Hydraulic loading rates will vary from soil to soil. The infiltration rates depend upon the soil characteristics defining pore sizes and pore size distribution, soil morphological characteristics, including texture, structure, bulk density, and clay mineralogy.

3.2 DETERMINATION OF VOLUME OF EARTHWORM BIOMASS

The density of earthworm biomass required for the treatment of wastewater can be calculated by as follows,

The average requirement of earthworms for water treatment be 8000-10000 nos for 1m^3 of soli depth.

The soil volume of our vermiculture kit = lenghth x breath xdepth

= 0.37 x 0.2 x .006

The soil volume of our vermiculture kit = 0.0044 m^3.
No of earthwarms need,

0.0044m^3/1m^3 = x/10000

x =44 nos

Average weight of young and baby earthworms are 0.5 gm
Therefore ,theweigth of earthworms need = 0.5 x 96

= 480 gm

However, in this experiment we started with 96 worms of 480 gm in 0.00440 cum of soil bed, which comes to about 22,000 worms per cum of soil.

IV. THE VERMIFILTER KIT AND THE FORMATION OF VERMIFILTER BED

The study was carried out in a vermiculture kit located in environmental engineering lab(department of civil engineering) of Meenakshi Sundararajan Engineering College. The temperature in lab was maintained at 21.5C to 25C with 50% humidity. The VC kit contained about 15–20 kg of gravels with a layer of garden soil on top. This formed the vermifilter bed. It has provisions to collect the filtered water at the bottom in a chamber which opens out through a pipe fitted with tap. Above the chamber lies the non woven geo textile fibic sheet to allow only water to trickle down while holding the gravels above. The bottommost layer is made of gravel aggregates of size 12-16mm and it fills up to the depth of 4.5cm. Above this lies the aggregates of 4-6 mm sizes filling up to another 4.5 cm. On the top of this is the 4mm layer of aggregates of 1-2mm sizes mixed with sand. The topmost layer of about 6 cm consists of pure soil in which the earthworms were released. The worms were given around one week settling time in the soil bed to acclimatize in the new environment. As the earthworms play the critical role in wastewater purification their number and population density (biomass) in soil, maturity, and health are important factors. This may range from several hundreds to several thousands. There are reports about 8–10,000 numbers of worms per cubic meter of the worm bed and in quantity (biomass) as 10 kg per cubic meter (cum) of soil for optimal function . However, in this experiment we started with 96 worms in 0.00440 cum of soil bed, which comes to about 22,000 worms per cum of soil. This means even lesser number of worms could have done the job.

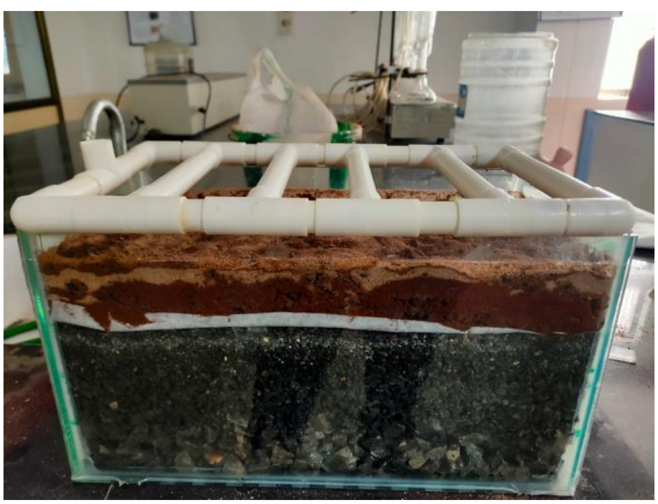


Fig.4 Formation of vermifilter bed.

The control kit without earthworms: comparison to assess the precise role of earthworms as biofilters A control kit (exact replica of vermifilter kit but devoid of earthworms) was also organized for reference and comparison. It is important to note that the soil and sand particles and the gravels in the kit also contribute in the filtration and cleaning of wastewater by ‘adsorption’ of the impurities on their surface. Parameters studied in sewage vermifiltrationThe untreated sewage that was fed to the vermifilter kit and treated sewage which was collected at the bottom of the kit in a chamber were analyzed to study the biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), turbidity, and the pH value.

V. EXPERIMENTAL PROCEDURE

The experimental procedures Around 5–6 L of kitchen wastewater(hash wash sink) were kept in calibrated 20-L capacity PVC drum. These drums were kept on an elevated platform just near the vermifilter kit. The PVC drums had tap at the bottom to which an irrigation system was attached. The irrigation system consisted of simple 0.5-inch polypropylene pipe with holes(2-3mm) for trickling water that allowed uniform distribution of wastewater on the soil surface (vermifilter bed). The wastewater percolated down through various layers in the vermifilter bed passing through the soil layer inhabited by earthworms, the sandy layer, and the saw dust gravels, and at the end was collected in a chamber at the bottom of the kit. Next day this treated wastewater from both kits were collected and analyzed for BOD5, COD, and the TSS. The hydraulic retention time (HRT) was kept uniformly between 1–2 h in all experiments.

. In batch process, we maintain wet to dry time ratio 1:3 has been used (each cycle included wastewater flow for 1 h, retention for 3 h) if the system has to work without choking and clogging. The complete setup of the vermifiltration been shown in the Fig.5

Fig.5 VERMIFILTRATION KIT

VI. SAMPLE PREPARATION

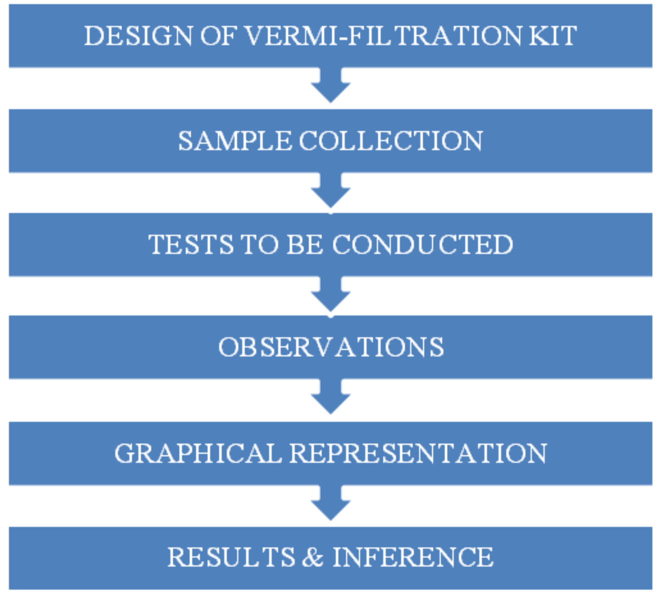
Water is an essential and rare source required for socio-economic development but fresh water sources are now in declining situation. Grey water is originated from various locations i.e. kitchen, bathroom, laundry, cloth washers, bath tubs and black water is generated from toilets. Untreated grey water should not be useful for toilet flushing as well as for gardening. Untreated grey water can be treated by simple way - collecting grey water, piping and dispersing. It may include fine/course screening or filtering to remove particulate matter, disinfectants to remove pathogens and last to the storage tank. Potential health effects also related with grey water treatment. If untreated grey water get stored for more than 8-10 hours, bacteria which are presents in grey water will grow fast that is harmful to human health. Due to long storage of grey water create nuisance of mosquitoes, odor which will face to the nearby areas. Maximum amount of grey water gets used without any treatment for irrigation purpose. Grey water formation totally depends on availability of water, habits of people as well as locality. Grey water reuse offers various advantages which will help to save money by water authorities on clean water supplies as well as sewage flow and public water demand of potable water.

6.1 PROCESS OF SAMPLING:

- ✓ Use a clean glass or plastic bottle for samples Label a bottle (e.g. point and kind of sampling, date and time, name of sample collector, parameters of analyses).
- ✓ Do not touch the inner of the bottle with your fingers (contamination).
- ✓ Through the first flush out of a pipe away and than take your sample Stir the sample before you fill it into the flask Fill the bottle up to the top.
- ✓ Carry the sample as soon as possible to the laboratory or analyse it onsite (biological degradation still takes place!) Cool the sample, do not leave it in the sun.
- ✓ Check and clean automatically working sampling units frequently. Control the cooling system (wrong temperature will change the ingredients).

The average BOD value of the raw sewage ranged between 200 and 400 mg/l, COD ranged between 116 and 285 mg/l, the TSS ranged between 300 and 350 mg/l, and the pH ranged between 6.2and 7.8. There is great fluctuation in these values depending upon catchment area, flow rate, and season. Sewage from industrial areas can have high COD values, very low or high pH, due to accidental mixing of industrial wastewater.

VII. METHODOLOGY



VIII. CONCLUSION

Many developing nations cannot afford to construct and maintain costly STPs. They need more options for sewage treatment at low cost. In both developed and developing world, at least for new developments, centralized sewage treatment system may not fulfill sustainable wastewater management requirements in future due to ever-increasing demand. Individual households or a cluster of homes can treat their domestic wastewater at source in a de-centralized manner so as to reduce the burden (BOD & COD loads) on the sewage treatment plants (STPs) down the sewer system. The combined effect of the Eisenia fetida worms and the microbial-geological system successfully treat sewage wastewater.

It is an alternative, sustainable technology for sewage wastewater treatment. The design of the vermifilter must ensure optimum removal of organic pollutants in the sewage wastewater with respect to the wastewater flow rate, earthworm density, hydraulic retention time and hydraulic loading rate. Vermifiltration successfully lowers the sewage wastewater BOD, COD, TDSS and turbidity as well neutralizing the pH. The treated sewage wastewater can be used for irrigation purposes.

IX. INFERENCE

- The treated pH water increased from being acidic to neutral.
- The turbidity of sewage wastewater is decreased by 96%.

- The Biological Oxygen Demand and Chemical Oxygen Demand of sewage wastewater decreased by 88% & 81.55%
- The Total Dissolved Solids of sewage waste water is decreased by
- Decreases upto 90% observed for all wastewater physicochemical parameters.
- Initial trials using wood chips and wood dust, as an external carbon source in the vermifiltration media, is also showing promise as a means of ammonia removal.
- It can utilize waste organics that otherwise cannot be utilized by other technologies.
- Achieve greater utilization (rather than the destruction) of waste materials that cannot be achieved by other technologies.
- It does all by 'enzymatic actions' and enzymes are biological catalysts giving pace and rapidity to all biochemical reactions even in minute.

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