# Domestic Wastewater Treatment

## Vermi-Filter

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**Abstract: The unprecedented growth of population has placed lot of stress on natural resources like water, air, etc. Water is vital to living being and is of infinite quantity. Human activities have made water unfit for use in several cases. The depleting sources of water and uneven rainfall tendency have made water crises severe. Of the various alternatives in the water Resources Management recycling, reuse takes a prime slot. The case study is aimed to test the suitability of vermiculture biotechnology in the recycling of domestic wastewater of the college hostel. Severe water shortage of several month of year has resulted in need for urgent development of suitable technology to reuse the wastewater. A three-stage vermifilter is designed and domestic wastewater from hostel mess is passed stages of vermifilter. The Vermicasting used as the biofilter media has shown remarkable capacity for reducing the BOD, COD and Suspended solids level in the effluent. This pilot plan needs to be tested for other condition like organic loading, detention period, temperature, etc. to arrive at a viable response to the demanding need of suitability technology.**

### 1. INTRODUCTION

Human and animal habitations generate large quantities of wastewater, reasonable part of these waste water are collected and recycled .The balance is mostly organic and nontoxic, quantity of such nontoxic organics is quite large.Several technologies are operating in India and other parts of the World towards handling of these wastes, primarily aimed at disposal of organic wastes. These technologies incur expenditure of resource (i.e. electricity, chemicals etc.) to concentrate or wastefully oxidize the organics many of these technologies do not generate net income they are not willingly adopted by the people a large. This leads to accumulation of wastewater into the environment and affecting detrimentally the quality of our lifeline, soil, water and air. In nature these organic serve as food for soil organism and drive the life process of the soil. In this paper therefore we study the principle of waste organic processing in nature so that these can be integrated into man made industrial processes. Ecological process involves a food chain in which several organisms participate. Earthworms are integral components of the soil food chain and their critical role in maintaining the soil health can be captured for processing of waste organics. Such technology could have benefit of

- Keeping the environment clean
- Utilizing the bio-energy of waste organics for driving the soil processes thus providing an economic value for organic waste.

In this paper we study the feasibility of vermiculture biotechnology for bioconversion of domestic wastewater. The domestic wastewater can be directly applied on vermiculture soil. The impurities in the water are trapped / adsorbed in the soil and the excess water percolates through vermiculture soil. Vermicasting provides excellent drainage conditions and very high specific surface for bacterial activities. The organic matter enhances various soil bioprocesses. The extra amount of water can be allowed to recharge ground water or can be collected for reuse by constructing 'Recovery Type Vermifilter.

### 2. OBJECTIVE OF STUDY

- To assess the suitability of process of vermification for domestic wastewater of hostel mess.
- To study the effect of variation of organic loading of the waste on the performance of this process in terms of the efficiency of removal of BOD as well as COD.
- To study the biodegradation pattern during the process of vermification of the important parameters like suspended solids.

### 3. VERMICULTURE BIOTECHNOLOGY

Biotechnology essentially involves large-scale application of bio-system for economics and effective processing of the material to produce value added products. Vermiculture biotechnology is an

aspect of biotechnology involving the use of earthworm as versatile natural bioreactor for effective recycling of nontoxic organic solid and liquid wastes. Vermiculture means culturing of earthworms. The earthworms can be effectively employed to maximize the growth of aerobic bacteria for waste processing. This can be achieved by providing them with proper living condition and feeding them the organic waste. This technique does not require expensive laboratories of sophisticated equipments.

## 4. SYNTHESIS OF VERMICULTURE

Vermifilter process is an Ecotechnology that ensures environment friendly bioprocessing of wastewater into vermicasting and clean water for reuse. Vermifilter is a self-designed and self maintain ecosystem. Vermifilter process consist of feeding waste organics to a vermifilter packed with adsorbed biomedium. Vermifilter biomedium consist of:

| | |
|---|---|
| Organics | Valuable substrates |
| Bacteria | Speedy and versatile bioprocessing agent |
| Plant roots | Direct the soil process, absorb the plant growth factors |
| Soil | Ideal biomedium |
| Earthworms | Aerobic natural bioreactors, regulator of soil microorganism |

## 5. EXPERIMENTAL SETUP

The experimental setup is set at suitable place in the NRI 1 Hostel of Nandha College of Technology. The hostel has capacity of 309 students. The domestic wastewater obtained after washing the utensils is used as experimental liquid. The experimental setup consists of three G.I boxes fabricated at college workshop having cross sectional dimensional of 500x500mm height of about 600mm. the boxes are provided with the holes at the bottom for water recovery. A layer of coarse gravel (25mm.size) is laid at the bottom. This layer supports a 30mm thick layer of 12mm.gravel which in turn supports 20mm.thick layer silt free sand passing through 1.70mm.I.S sieve. These layer make up the drainage system which does not play any major role in the vermification process except providing the support for upper vermification and providing drainage above the sand layer 300mm.thick layer of vermification with earthworm are placed and Canna tree are planted in each box, the vermifier are watered (by sprinkling) for ten days for acclimatization of the system. Wastewater is fed to VF1 by an arrangement shown in figure.

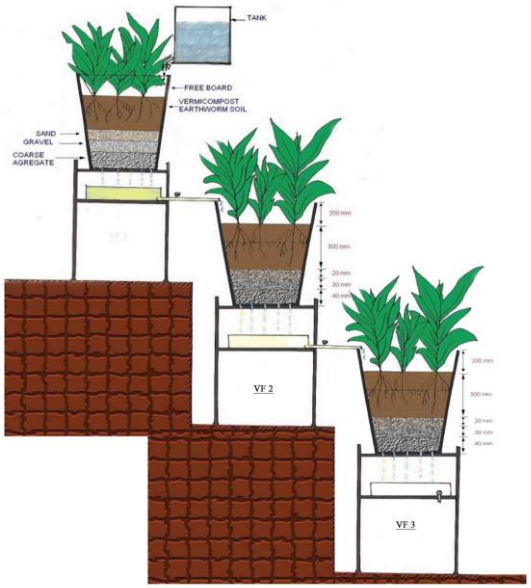



***Figure*: Experimental Setup**

The domestic wastewater is allowed into VF1 controlling device at the rate shown in table no.1

Table No. 1: Rate of hydraulic loading

| Date | Hydraulic loading |
|---|---|
| 24/10/2015 to 4/11/2015 | 20 ltrs. Per day (water) |
| 5/11/2015 to 11/11/2015 | 20 ltrs. Per day (sewage) |
| 12/11/2015 to 18/11/2015 | 30 ltrs. Per day (sewage) |
| 19/11/2015 to 25/11/2015 | 40 ltrs. Per day (sewage) |
| 26/11/2015 to 3/12/2015 | 50 ltrs. Per day (sewage) |
| 4/12/2015 to 11/12/2015 | 60 ltrs. Per day (sewage) |

In order to access the performance of V.F unit samples were collected from the mess drainage line. This sample was tested for S.S, COD, BOD before feeding to VF1 the results are shown in Table no 2. The samples of waste water is then applied over the vermifilter VF1 at the constant rate of flow so that the rate of infiltration of vermifier Was equal to the rate of application of sewage and no ponding occurred. The output from the first vermifier was applied over the second vemifier. The sewage and the effluents from VF1, VF2, and VF3 were tested for BOD, COD and suspended solids at regular intervals;

the results are tabulated in the subsequent tables and represented in the form of graph.

## 7. LABORATORY ANALYSIS

All the samples of the waste water which being collected as per the above sampling program were analyzed into laboratory of Nandha College of Technology for important parameter like Biochemical Oxygen Demand, Chemical Oxygen Demand and Suspended solids of the waste water samples.

| Sr. No | Parameter | Concentration |
|---|---|---|
| 1. | pH | 6.4 |
| 2. | Temperature | 24°C |
| 3. | Suspended solid (mg/lit) | 305 |
| 4. | COD(mg/lit) | 546 |
| 5. | BOD5(mg/lit) | 208 |

Table 2:The Characteristics of Waste Water Collected from NRI 1 Hostel, NCT.

## 8. PRESENTATION OF RESULTS OF LABORATORY ANALYSIS

The results of the laboratory analysis carried out during the study project are presented in tabular format as well as through curves. The overall quality of waste water from NRI 1 Hostel is revealed from Table no 2 which is prepared on the basis of analysis of different samples

| Sr. No. | Date | Suspended solids in mg/l | | | |
|---|---|---|---|---|---|
| | | Initial | VF 1 | VF 2 | VF3 |
| 1 | 11/11/2015 | 310 | 26 | 25 | 24 |
| 2 | 18/11/2015 | 312 | 22 | 20 | 19 |
| 3 | 25/11/2015 | 306 | 24 | 19 | 17 |
| 4 | 03/12/2015 | 325 | 18 | 16 | 15 |
| 5 | 11/12/2015 | 290 | 19 | 15 | 14 |

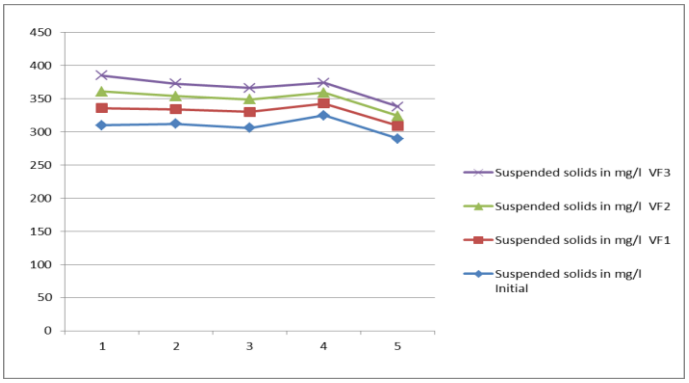
| Date | COD in mg/l | | | | BOD in mg/l | | | |
|---|---|---|---|---|---|---|---|---|
| | Initial | VF1 | VF2 | VF3 | Initial | VF1 | VF2 | VF3 |
| 11/11/2015 | 546 | 212 | 190 | 187 | 208 | 51 | 21 | 21 |
| 18/11/2015 | 514 | 185 | 126 | 125 | 215 | 34 | 18 | 17 |
| 25/11/2015 | 530 | 160 | 100 | 91 | 203 | 21 | 09 | 09 |
| 03/12/2015 | 540 | 140 | 84 | 75 | 211 | 19 | 08 | 08 |
| 11/12/2015 | 536 | 128 | 76 | 65 | 219 | 16 | 08 | 08 |

Table 3: Variation of Suspended Solids

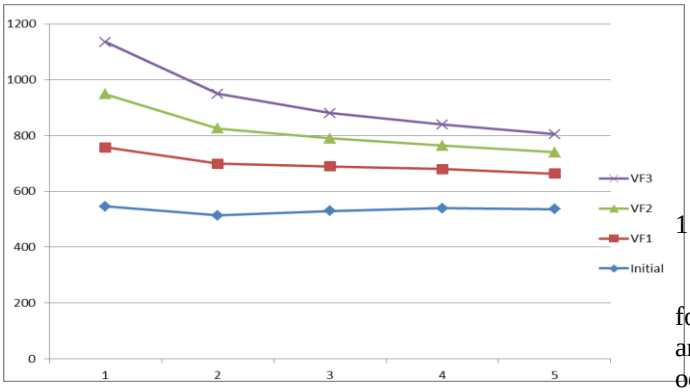
| Date | % Reduction in COD | | | % Reduction in BOD | | | % Reduction in suspended solid | | |
|---|---|---|---|---|---|---|---|---|---|
| | VF 1 | VF 2 | VF3 | VF 1 | VF 2 | VF 3 | VF 1 | VF 2 | VF 3 |
| 11/11/2015 | 61 | 65 | 65 | 75 | 90 | 89 | 91 | 91 | 92 |
| 18/11/2015 | 64 | 75 | 75 | 84 | 92 | 92 | 92 | 93 | 93 |
| 25/11/2015 | 70 | 81 | 81 | 90 | 96 | 95 | 92 | 93 | 94 |
| 03/12/2015 | 74 | 84 | 86 | 91 | 96 | 96 | 94 | 95 | 95 |
| 11/12/2015 | 76 | 86 | 87 | 93 | 97 | 92 | 94 | 95 | 95 |

Table 4: Variation of COD and BOD

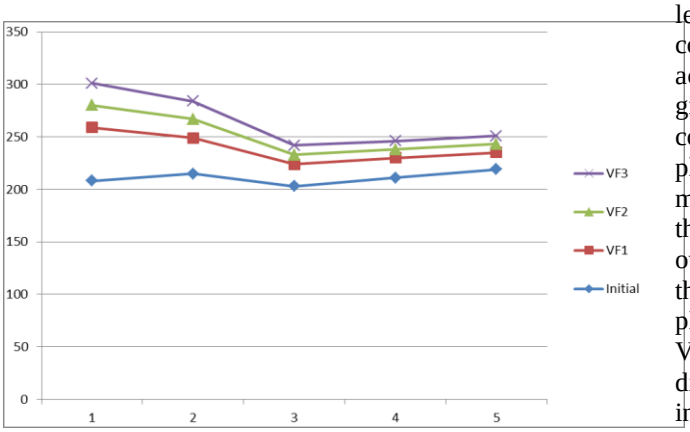
Table 5: Percentage Reduction in COD, BOD and Suspended Solids




Graph1: Variation in Suspended Solids




Graph 2: Variation in COD




Graph 3: Variation of BOD

For each of the organic loading rate applied to the vermifilter tables are prepared to depict the pattern of biodegradation of waste in terms of reduction in the concentration of various parameters like COD, BOD and S.S. These details are presented in Table No.3 through table no 5.Each of these tables presented the daily reduction in concentration of particular parameter in VF1,VF2 AND VF3 throughout the duration of 7 days for which a particular loading rate was constantly maintained. The pattern of biodegradation of the domestic wastewater through the process of vermification in terms of percentage removal of different parameters is presented in graphical form also

## 10. RESULTS AND DISCUSSION

- The percentage reduction in concentration of **COD** in VF1 - 61.00% to 76.00% ,VF2 - 65.00% to 86.00% & VF3 - 65.00% to 87%.
- The percentage reduction in concentration of **BOD** in VF1 - 75.00% to 93.00%,VF2 - 90.00% to 97.00% & VF3 – 89.00% to 92%.
- The percentage reduction in concentration **suspended solids** in VF1 -91.00% to 94.00% ,VF2 -91.00% to 95.00% & VF3 – 92.00% to 95.00%.

## 11. OBSERVATION

During the course of experimentation it was found that there were no sign of any development of anaerobic condition in the model as there was no odour or no flies in spite of daily application of sewage. The effluent from both the vermifilter was totally odour free. It shows pale yellow color due to leaching of some dissolved salts. The intensity of this color decreased as the system stabilized with acclimatized over the span of one months. The growth of plants in VF1 was found to be more as compared to that of plants in VF2 and the growth of plants in VF2 is greater than VF3. This is because more organics were trapped in VF1.Eventually when the acidity was developed in the vermifier due to overloading of organic matter, it was bioindicated by the presence of ants, which got proliferated in acidic pH. Immediately the rock dust was sprinkled over the Vermifilter to neutralize the acidity. The ants were to disappear from next day. This was happening at an interval of around 20 days. Canna plants gave birth to new shoots old plants were cut, so that the new plants could grow efficiently. The younger plant consumed the metabolites i.e. nutrients more efficiently and the effluent of better quality was obtained. Also the Canna plant provided shade for the vermifier surface as well as oxygen to earthworms. The hydraulic loading could not be increased above 60 liters / day for the model as frequent pounding was observed. The efficiency of vermifilter increased as the system stabilized. As seen from the graph after an initial period of 20 days there was an increased in reduction of parameter like BOD, COD and S.S.

## 12. ADVANTAGES OF VERMIFILTER UNIT:

- The energy consumption of a vermifilter unit is very less.
- The operation of this unit is very simple.
- This unit requires very less maintenance.
- There is no chance of formation of sludge and hence problem of sludge disposal or backwashing of filter do not arise.
- The harvesting of vermicasting fetches extra income

- Quality of effluent is much better compared to conventional treatment plant.
- Eutrophication is completely prevented as nitrates and the plant utilizes phosphates. Hence pollution of water bodies does not take place.

## 13. DISADVANTAGES OF VERMIFILTER UNIT:

- Land requirement in this unit is more than conventional treatment plants.
- Feasibility on large scale is yet to be practically checked.
- This technology is not suitable for highly toxic effluents from chemical industries.
- Initial time requirement for production for products of vermicasting is more.
- This unit requires large initial investment.

## 14. CONCLUSION:

The depleting natural resources in terms of quality and quantity need to be stabilized which are to be returned to the nature without destroying its natural forms. Recycling is one of the best techniques. Vermifilteration of domestic wastewater is advantageous over the conventional treatment system and they are eco-friendly and economical. This system offers an easy handling and utilization oriented method of bioconversion of wastewater. The present paper report would be developed into a major treatment plant for water supply to plantation in college campus.

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