TREATMENT OF GREY AND SMALL SCALE INDUSTRY WASTE WATER WITH THE HELP OF VERMI-FILTER

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Abstract

Water is becoming one of the important and limited resources available to us. Reuse and recycle is the best option to deal with water scarcity. Therefore an attempt is made to reuse the grey and small scale industry water after giving low cost effective treatment with the help of vermi-filter. Vermi-filtration is a new and innovative technology in which the combined action of earthworms' activity and the adsorption properties of other materials like soil, sand and gravel particles on the organic pollutants are applied for wastewater treatment. *This study is aimed to test the suitability of vermi-filter and non-vermi-filter for the various critical parameter namely pH, removal efficiency of BOD, COD and TSS. From the present experiment data it was found that the efficiency of vermi-filter is much better than Non vermi-filter (normal filter). Vermi-filter is an eco-friendly technology which does not produces sludge and is very economical.*

Keywords

Earthworms, Eisenia fetida (tiger worm), Vermi-filter, Non-vermi-filter, Ingestion, Biodegradation, Biochemical oxygen Demand (BOD), Chemical oxygen Demand (COD)

1.INTRODUCTION

Fresh water is becoming one of the most limited resources available to us. Today we are left with no other option but to conserve reuse& recycle every drop of water that we use. Due to rapid increase in population, industrialization and development, there is an increased opportunity for grey-water reuse in developing countries such as India. India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. [1]

The International Water Management Institute (IWMI) predicts that in India by 2025, one person out of three will live in conditions of absolute water scarcity (IWMI, 2003). It is therefore very essential to reduce surface and ground water use in all sectors of consumption, to substitute this with alternative water resources available and to enhance water use efficiency through other options like reuse. These alternative resources include rainwater harvesting and reuse, grey-water and waste water reuse. It is estimated that 38355 million liters per day (MLD) of sewage is generated in major cities of India, but the sewage treatment capacity is only of 11787 MLD. [2] This uncollected sewage is directed to the water bodies and hence is the cause of pollution. Similarly, only 60% of industrial waste water (large scale industries) is treated while the small scale industries discharge their waste water directly into water bodies which ultimately pollutes the nearby river. [3]

Hence to meet the increased demand of fresh water and to reduce the pollution load on the water bodies, an economical treatment approach is required. Reusing waste water (includes both domestic and industrial) is a new and attractive economic alternative and helps conserve an essential commodity for future generations. The treatment methods should be efficient so that the treated waste water can be reused for certain application.

Research has been done to reuse the grey water efficiently and help to reduce the demand. [4, 5] It is also estimated that grey-water reusing can help to save 40% to 45% of the annual water consumption.

As water for industrial application becomes less easily accessible, industry is looking for ways to recycle and reuse. For efficient reuse of the industrial waste water, an extensive treatment system is required as the contaminant concentration is high and toxic. Generally chemical treatment methods are adopted to treat industrial influent; these methods incurred huge cost and require skilled maintenance. Limited literature is available for the use of biological methods to treat and reuse the industrial waste water. [6, 7]

One such emerging technique is vermi-filter which is cost effective and efficient. The treated effluent is suitable for may reuse application. Vermi-filtration of waste water using waste eater earthworms is a newly conceived technology. Earthworms' body works as a "Bio-filter" and they have been found to remove the BOD_5, COD & TSS by almost 80-90% from waste water by the general mechanism of "Ingestion" & "Biodegradation". [8]

A low cost treatment system with adequate efficiency is essential for small scale industries which are not able to treat their waste water because of unavailability of funds and discharging it into water bodies and causing water pollution. As the grey water which generates from bath-room is less contaminated as compare to other waste water and can be treated separately to reduce the burden on the sewage treatment plants (STP). Therefore a low cost treatment system is required to treat effluent of small scale industries and grey water to make it fit for reuse.

Hence in the present work, experimental setup of a vermi-filter was prepared and the efficiency of treatment was studied for industrial waste water and grey water. Also efforts were made to compare a vermi-filter with a Non vermi-filter (normal filter).The comparison was made based on critical parameters like pH, BOD, COD, TSS.

2. METHODS AND MATERIALS

2.1 Experimental set up

A vermi-filter and a non vermi-filter were prepared by using the locally available material. Figure 1 shows the earthworm used in the present study and Figure 2 describe the schematic layout of a vermi-filter. The filter consists of four layers. The bottom-most layer was made of gravel aggregate of size 20mm and it fills up to the depth of 40mm. Above this lies the layer of aggregate of 10mm size filling up to depth of 30mm.On the top of 10 mm aggregate, the sand passing through 2.36 mm I.S sieves were placed up to a depth of another 30mm. The top most layer consist of a mixture of soil & cow dung in 1:3 proportion and were placed at the top of sand layer up to depth of 120mm in which the earthworms Eisenia fetida (tiger worm), were also released.

Figure 1: Earth Worms used in the vermin filter

In the vermi-filtration system, suspended solid particles get trapped on top of the vermi-filter and, after getting processed by the earthworms present in the mixture of soil and cow dung, are fed to the soil microbes immobilized in the vermi-filter. The organic and inorganic solids which are in dissolved and suspended form get trapped by adsorption and stabilized through complex biodegradation processes which occur in the “living soil” inhabited by earthworm and the aerobic microbes. Aggregation of soil processes and aeration by earthworms and the resultant soil stabilization makes the complete filtration system very effective, while reducing the overall space requirement compared to a conventional filtration system. [9-11]

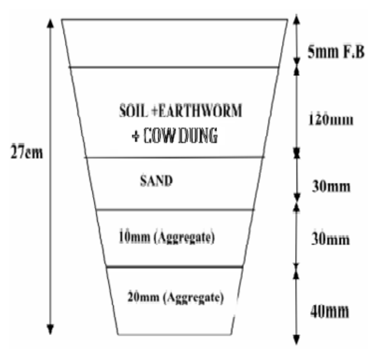

Figure 2:Vermi-filter kit

A non-vermi-filter is a filter without earthworms and hence the only difference is in the top most layer, rest all the layers were same as the layers of a vermi-filter (fig. 3). The top most-layer does not contain the earthworms and only contain the soil. This filter works on the adsorption mechanism where the impurities are adsorbed by the soil and sand layers and hence removal takes place.

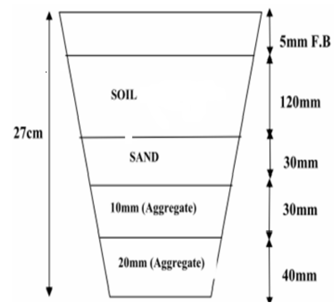

Figure 3: Non-Vermi-filter kit

1.2 Experimental method used in vermi-filter& Non-Vermi-filter:

The influent from dairy and paper and pulp industry and grey water from canteen of the college campus was collected. The influent (5 litres) was stored in a plastic bucket of 7 litres capacity. These buckets were kept on an elevated platform just near the vermi-filter for maintaining proper flow. The buckets had tap at the bottom to which irrigation system was attached. The waste water distribution system consist of simple 0.5 inch flexible pipe with holes for trickling water that allowed uniform distribution of waste water on the soil surface (figure 4). The waste water is percolated through various layers of filter bed & at the end it was collected in a chamber at the bottom of the kit. Same day this treated water from both the filter is analyzed for pH, BOD, COD & TSS.

Figure 4: Experimental setup

1.3 Analytical methods used in laboratory:

Analysis of mixed waste water (Grey water and small scale industry waste water) was carried out in the Environmental Laboratory of the Civil Engineering Department, VIIT College, Pune. It was done to analyze all the critical parameters pH, BOD, COD and TSS value of the influent and effluent waste water obtained from vermi-filter & non-vermi-filter. (Lab test are performed as per IS3025 Part 44:1993).

3. Results & Discussion:

3.1 Biological Oxygen Demand

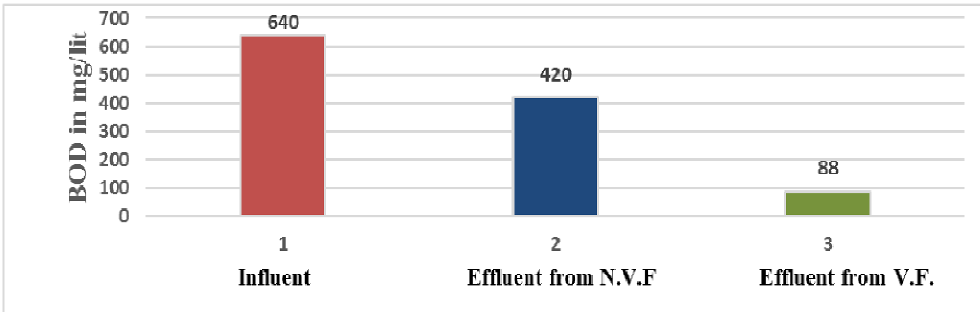

Figure 5: BOD of influent and effluent

It can see from figure 5 that the percentage reduction of BOD in vermi-filter ranges from 87% to 90% while in non-vermi-filter it was found to be 33% to 37%.

3.2 Chemical Oxygen Demand:

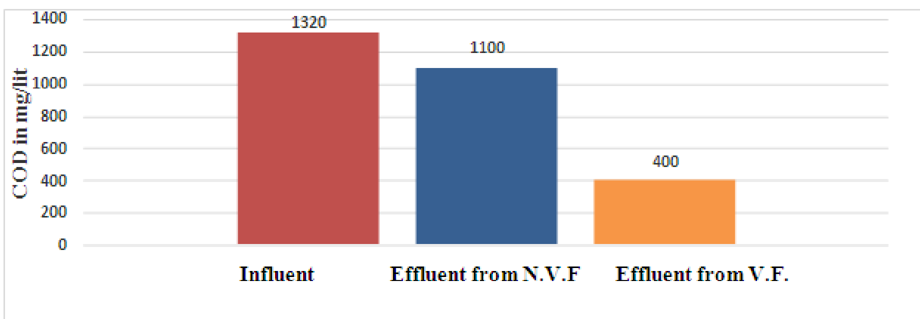

Figure 6: COD of influent and effluent

Figure 6 shows that the percentage of reduction COD in vermi-filter ranges from 70% to 90%. This reduction in COD may be due to earthworms that secrete the enzymes which help in the degradation and decomposition of several other chemical which cannot be decomposed by microbes. The COD reduction in non vermi-filter was found to be 16% to 20%. This may be due to increase the formation of biofilms of decomposers microbes in geological system. Biological process and filtration are mechanism to remove COD.

3.3 Total Suspended Solids:

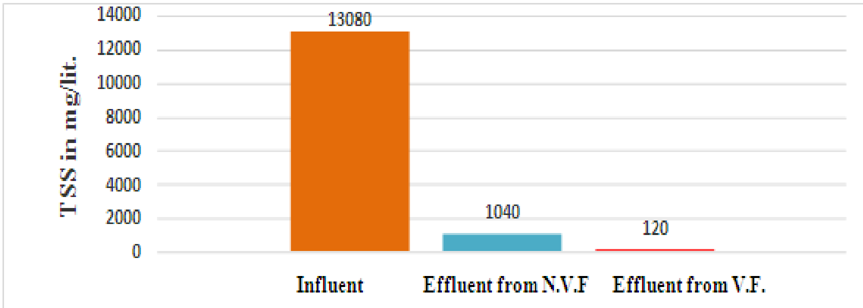

Figure 7: TSS of influent and effluent

The percentage reduction in concentration of TSS of waste water by vermi-filter ranges from 90% to 99% (figure 7) whereas in non-vermi-filter it was found to be 80% to 90%.

3.4 pH:

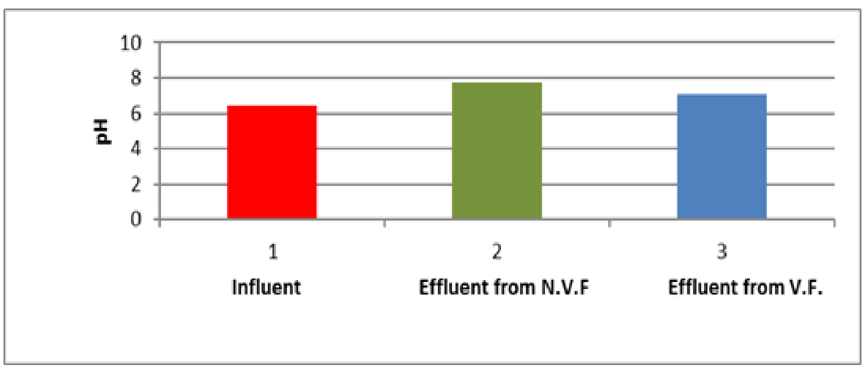

Figure 8: pH of influent and effluent

Earthworms are sensitive to change the pH. The prefer condition is neutral reaction. The pH of waste water in the initial stage was 5.5 to 6.5 (acidic nature). But as the degradation started in vermi-filter the pH range was found to be 7.2 to 7.4 (alkaline) while pH remains same in effluent as in influent in non-vermi-filter.

4.Conclusion:

From the experimental data, it was found that vermi-filter is more efficient than non- vermi-filter in removal efficiency of BOD, COD TSS, pH.

The major conclusions drawn from the project for vermi-filter are given below:

1.Zero sludge produce.
2.Efficiency is achieved up to 90%.
3.Convenient to use.
4.It has an in-built pH buffering ability and hence can accept waste water within a pH range 4 to 9 without any pH adjustment.
5.Economical & Eco-friendly.
6.The vermi-filtered water is clean and can be recycled in many industrial plants for production processes & various secondary uses.
7.Filtered water can also be used for irrigation.

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