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Study of Biofiltration System and its Applications

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Abstract - *The aim of the study was to study the bio filtration system i.e. by Vermi-filtration. The study was made on several past researches, and the study was also done on the currently executed Aba Bagul treatment plant located at Sahakarnagar Pune. This study explains the working and methodology of vermin-filtration system in treatment of waste water. It also explains which species of earthworms are suitable for vermin-filtration. This study also explains the working and analysis of work done on experimental setup of vermin-filtration which was executed in APCOER college to conduct experiment on greywater collected from boys hostel located in APCOER's campus. The conclusion was made that there are four efficient species which gave exceptional results in past, the name of the species were Red tiger worm, African Night crawler, Indian blue worm and Red worm.*

Key Words: Bio filtration, Vermi-filtration, Earthworm, Aba Bagul Treatment plant.

1. INTRODUCTION

Indian population represents 16% of world population but we only have 2.5 % of land area and 4 % of total water resources i.e. we have less resources and a large audience as compared to other nations, Yet we are wasting our resource and polluting it. According to The International Water Management Institute (IWMI) in India one out of three people will live in conditions of absolute water scarcity by 2025.It also predicts that per capita domestic water demand in India is likely to increase from the estimated 31 m3/person/year in 2000 to about 46 and 62 m3/person/year by 2025 and 2050 respectively Therefore it is necessary for us to conserve, reduce and reuse water for our daily needs. Around 80 % of water supplied by municipal authorities return as sewage in all major cities in India. 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 this uncollected sewage is directed to the water bodies and hence is the cause of pollution. Due to high cost of conventional treatment process,. Therefore there is a huge scope for cost treatment process which is beneficial in both parameters i.e. Economy and Environmental friendly.

The reuse of wastewater is an effective solution of our current problems, if we can reuse the wastewater generated by us it will reduce the amount of wastewater to be disposed and it will also reduce the amount of water supplied by municipal authorities.

1.1 Bio-filter

Any type of filter media with attached biomass on the filter media can be defined as a Bio filter. The filtration process in which the pollutants are removed due to Biological degradation rather than physical straining, is called Bio-filtration. Vermi-filtration is an aerobic treatment process. In vermi-filtration earthworms play an important role their body works as a bio-filter and it extends the microbial metabolism by increasing their population.

1.2 Methodology

Flow chart for the working of plant is as follows:

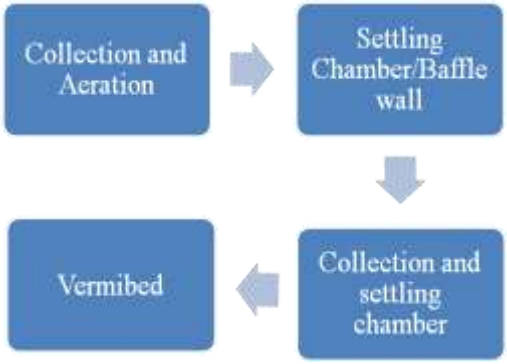


Fig 1 Shows Vermi-filter Treatment Plant

1.2.1 Collection and Aeration

Fig 2 Shows Aeration by means of Aerator

The first process of treatment is collecting waste water in first container, After collection of waste water it is aerated by the means of aerator, this aeration process increases the DO level in waste water and it also keeps the solid particles suspended and after some retention time some of the solid particles settle down at the bottom of container, then after settling of solid particles it is allowed to pass for next process i.e. Settling chamber/baffle wall.

Fig 3 Shows Retained solid particles

1.2.2 Settling Chamber/baffle wall

Fig 4 Shows settling chamber and baffle walls

After Aeration water is allowed to pass from container 1 to container 2. Flow is regulated by the means of valve provided after container 1. There are three baffle walls in the settling chamber which creates four compartment water passes from compartment one to compartment four do to upside down movement it pushes the suspended particles to settle at the base of each compartment after retention time it is allowed to pass waste water to further process.

1.2.3 Collection and settling chamber

When water completes two stages of treatment, almost 90% of the solid particles are settled, then this water comes to collection chamber and it settles the remaining suspended particles so it does not clog the sprinkler which is in next stage of treatment

Fig 5 Shows Collection Chamber

1.2.4 Vermi-bed

Fig 6 Shows Vermi-bed

After settling chamber water is further passed in vermi-bed the water is allowed to percolate in the bed by means of small pipes provided in the main pipe. The composition of vermin bed is as follows:

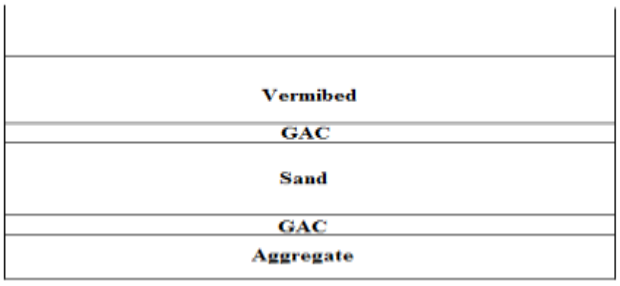


Fig 7 Shows Layers of Vermi-bed

In vermin-bed the bottom most layer is of aggregate, the layer of aggregate is of 4 cm, the size of the coarse aggregates were greater than 4.75 mm, the role of coarse aggregate was to provide proper foundation for the upper layers

Fig 8 Shows Layer of Coarse Aggregate

The layer above aggregate is of GAC this layer comprises of 2 cm, Granular activated carbon (GAC) has a relatively larger particle size compared to powdered activated carbon and consequently, presents a smaller external surface, Hence due to larger surface area it was helpful for the creation of bio-film therefore we used GAC above coarse aggregate to create bio-film.

Fig 9 Shows Layer of GAC

The next layer above GAC was of river sand it comprises of 7 cm layer, fine sand plays an important role in filter bed due to small pores available it traps the smallest sized impurities and it also provides ample space for development of biofilm due to availability of larger surface area.

Fig 10 Shows Layer of River sand

The layer above sand is of GAC, this layer comprises of 2 cm, Granular activated carbon (GAC) has a relatively larger particle size compared to powdered activated carbon and consequently, presents a smaller external surface, Hence due to larger surface area it was helpful for the creation of biofilm therefore we used GAC above River sand to create biofilm.

Fig 11 Shows Layer of GAC above river sand

The next layer above GAC is of Vermi-bed, This is the uppermost layer of the bed and the most important layer of the bed. This bed was the mixture of cow dung, Soil and earthworms. We used red soil because of its capability of not soaking a lot of water. Now to chose the adequate species of earthworm was an important issue for us, Long term researches into vermin-culture have indicated that the Tiger Worm (Eiseniafetida), 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 Vermi treatment of a variety of solid and liquid organic wastes under all climatic conditions. Researchers done many experiments into field of waste water treatment technologies and found that E.fetida earthworms are effective for treatment of waste water and have sufficiently treated wastewater from different industries. So therefore we came to conclusion and we used Red tiger worm (E.fetida).

2. CASE STUDY

Even as the civic administration faces a challenge in treating its daily sewage, a project has been commissioned to treat 5 lakh liters of greywater per day and reuse it for gardening and at construction sites. This plant is first of its kind initiative by the civic administration. The PMC is the first municipal corporation in the country to commission such a project. It is executed on around 5,000 square feet of area on the premises by the PMC sewage department, the project took around 6 months to finish and was set up for around Rs 1.5 crore. The plant has been set up as per Maharashtra Pollution Control Board guidelines. The concept had first been mooted by local cooperator Aba Bagul.

The project is based on Tiger biofiltration technology. The technology uses a filtration arrangement consisting of Bio

media to trap and treat impurities from wastewater. The filtration medium is arranged in stacked manner with bio media on top. The top layer serves as active zone habitat for Bacteria and earth worms specifically bred for the purpose, while bottom layers provides structural support and free drainage for clear water. The trapped Impurities (Organic matter) are then consumed by bacteria and earth worms as an energy source for metabolism and reproduction resulting in reduction in organic matter (measured as Bio chemical Oxygen Demand).The system is designed with sufficient surface area and worm quantity. The worm consumes the BOD (Organic matter) load in 24 Hrs making bed available for next day loading. As the Natural oxygen transfer takes place no need of artificial air supply in form of blower resulting in less consumption of power and consumables and is therefore cost effective and environmental friendly. The tiger bio filter uses far less energy and space compared to similar technologies. Tertiary treatment in form of Pressure Sand Filter and Activated Carbon Filter can be used as an option for polishing the effluent.

Under the project a separate line has been laid to collect greywater from 1,200 homes in nearby areas. Water is brought along the Ambilodha (nullah) by gravity up to the Late Vasantrao Bagul Udyan where the treatment plant is located. The water gets treated by the biofiltration technique based on vermifiltration, pressure sand filter and activated carbon filter. Then this clean water can be used to wash toilets, in garden, and for construction purposes.

Future plan:

There is a plan to increase projects daily treatment capacity up to 10 lakh liter in its second phase. After commissioned fully, the project will be able to save the city 365 MLD of water.

Fig 12 Showing Tiger bio filter pilot plant at Sahakarnagar, Pune

Fig 13 Showing Tiger bio filter pilot plant at Sahakarnagar, Pune

3. EARTHWORMS

Earthworms are versatile waste eaters and decomposers. Earthworms are long, narrow, cylindrical, bilaterally symmetrical, segmented animals having without bones. They weigh around 1400 to 1500 mg after 8 to 10 weeks and their life span is about 3 to 7 years which varies with different species. Soil with very coarse texture and high clay content is not suitable for Earthworms.

Earthworms grind, aerate, crush and degrades the pollutants and act as a biological stimulator. Earthworms host millions of decomposer microbes in their gut and excreta called vermicast. This action helps to build a biofilm which further helps to create a colony form degrading microbes. Earthworms and microorganisms cooperate in Vermi Filter ingests and biodegrade organic wastes and other containments in waste water. This extends the food chain in normal bioprocesses and thus greatly improves sewage treatment efficiency. Earthworms increase the hydraulic conductivity and natural aeration by granulating clay particles .They also grind silt and sand particles, increasing the total surface area, which enhances the ability to absorb organic and inorganic from waste water. Intensification of soil processes and aeration by earthworms enable the stabilization of soil and the filtration system to become effective and smaller in size.

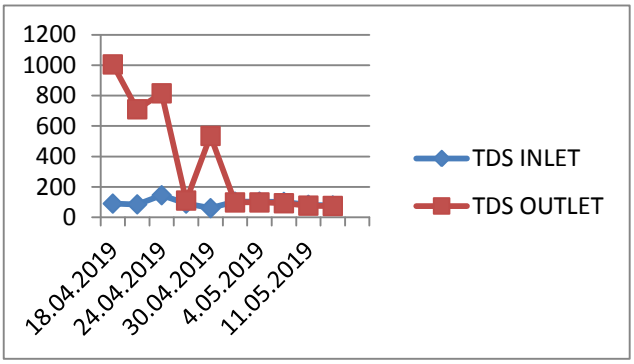
3. RESULTS

Fig 14 Shows Inlet and Outlet water samples after treatment

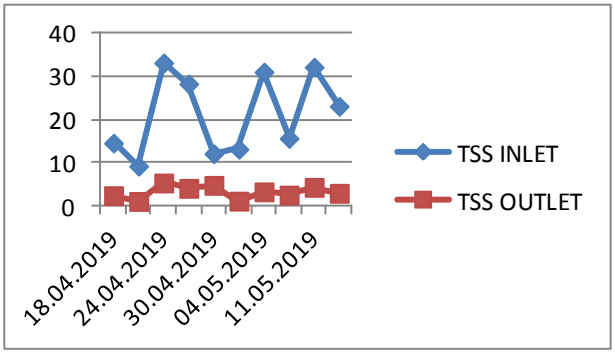
Analysis of waste water before and after passing the filtration system was done physical, chemical and biological characteristics like COD, BOD, TDS, TSS and ph were calculated. The result of COD, BOD, TDS and TSS of 10 inlet and outlet sample were conducted and their average is as follows

Sr. No.	Parameters	Inlet	Outlet
1	TDS (mg/lit)	90.3	358.34
2	TSS (mg/lit)	21.25	3.15
3	COD (mg/lit)	110.24	22.15
4	BOD (mg/lit)	33.9	6.34
5	pH	6.34	7.13

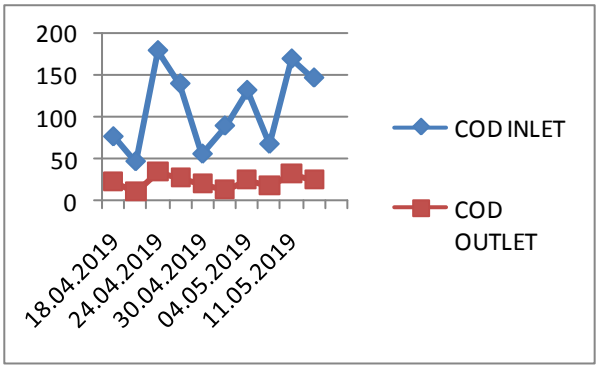
Table 1 Shows results of inlet and outlet sample



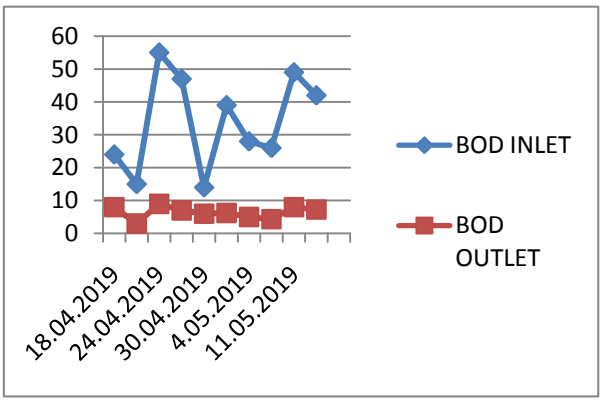
Graph 1 Shows TDS comparison



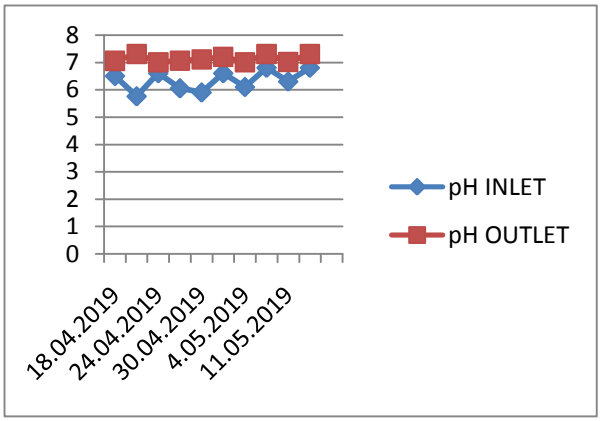
Graph 2 Shows TSS comparison



Graph 3 Shows COD comparison



Graph 4 Shows BOD comparison



Graph 5 Shows comparison of pH

4. CONCLUSIONS

Conservation of existing water sources is important, this can be achieved by recycling and reusing the treated waste water for various applications based on its suitability. The available quantity of the water sources depleted in last several years and the depletion is going on at the rapid rate. On the other hand due to rapid industrialization and growth of population globally, the quality of surface and subsurface water is contaminated beyond its acceptable limits. The direct disposal of untreated wastewater into the nearby water bodies and improper wastewater treatment facilities leads in spreading in water borne diseases.

After the study the conclusion was made that our future water scarcity problem can be solved in present by conserving and reusing water. Therefore it is now necessary for us to recycle and reuse the waste water.

Out of all species of earthworms the four species Red tiger worm, African Night crawler, Indian blue worm and Red worm were more effective and more resistant for severe environment conditions. Red tiger worm is best among these four species, because it can bear salinity in water and is resistant to severe chemicals.

LIMITATIONS

- TDS (Total Dissolved Solids) is not reduced due presence of salts in soil media.
- Human labor is required for daily maintenance.

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