International Journal of Science, Environment and Technology, Vol. 4, No 1, 2015, 140 – 145

ISSN 2278-3687 (O)

DOMESTIC WASTE WATER TREATMENT BY BIO-FILTRATION: A CASE STUDY

Damodhar J Garkal[1], J V Mapara[2] and Mandar Prabhune[3]

[1,2]Department of Chemical Engineering, Gharda Institute of Technology,
At-Po: Lavel, Tq: Khed, Dist: Ratnagiri, Maharashtra, India

[3]Mandar Prabhune, M/s Transchem Agritech Ltd, Vadodara, Gujrat, India

E-mail: djgarkal@gmail.com (**Corresponding Author*)

Abstract: Water scarcity is worldwide problem. Water is vital for survival of living being. The reuse of domestic wastewater for non-potable water application is a potential solution for water deprived region world-wide. In recent days many developing nations cannot afford to construct and maintain costly wastewater treatment plants. They need more options for wastewater treatment at low cost. In both developed and developing nations, centralized sewage treatment system may not fulfill sustainable wastewater management requirements in future due to ever-increasing demand.

Therefore in the present study an attempt is made to know the efficiency of vermifilter as decentralized treatment for parameters pH, total dissolved solids, removal of biological oxygen demand and chemical oxygen demand. In this study sewage water is treated using vermifilter containing earthworms and the results are compared with permissible standards of treated water. The average removal efficiencies of the vermifilter were as follows: chemical oxygen demand (COD) 68.52 %; biological oxygen demand (BOD) 72.05 %; total dissolved solids 15.42 %. During the process of vermifiltration, there was no sludge formation in the process and was also an odor-free process and the resulting vermifiltered water was clean enough to be reused for farm irrigation and gardens. Thus, earthworm activities had significant relationship with treatment efficiency of parameters by vermifilter of domestic wastewater.

Keywords: Vermifiltration, Wastewater, Bio-filtration, Earthworm, Biological oxygen demand, Chemical oxygen demand.

INTRODUCTION

Water is becoming limited resource in the world. International Water Management Institute (IWMI) predicts that per capita domestic water demand in India is likely to increase from the estimated 31 m^3/person/year in 2000 to about 46 and 62 m^3/person/year by 2025 and 2050 respectively [1].

Water scarcity and sewage disposal has become a worrying issue in India. Treatment of wastewater using a simple, decentralized, environment friendly method using minimum energy which is applicable to rural as well as urban areas at a low cost is need of the present.

*Received Jan 12, 2015 * Published Feb 2, 2015 * www.ijset.net*

More than 70 % of our fresh water bodies are polluted today. Groundwater table is depleting rapidly and the country is facing a major problem of groundwater contamination affecting as many as 19 states [2]. Multiple sources have been identified to be responsible for this situation. Discharge of untreated sewage in surface and sub-surface water courses is the most important water polluting source in India. One should also note that while the industrial sector only accounts for three per cent of the annual water withdrawals in India, its contribution to water pollution, particularly in urban areas, is considerable [2]. With only four cities in India having 100% treatment capacity installed, there is a large gap between generation and treatment of wastewater in India. Conventional treatment techniques of wastewater are expensive, since they have large requirements of land and continuous supply of electricity, both of which can be premiums in developing nations across the world [3]. In such a scenario, domestic wastewater recycling is an attractive option. Alternatives are needed urgently for treating domestic wastewaters which are low cost and having any significant negative impacts on the environment.

The reuse of sewage water for non-potable water application is a potential solution for water deprived region world-wide. Due to rapid industrialization and development, there is an increased opportunity for sewage water reuse in developing countries such as India.

BIOFILTER

It is an aerobic treatment which uses filtration technique called vermifiltration. Vermifiltration is emerging out low cast sustainable technology for liquid waste treatment. In vermifiltration earthworm body works as a bio-filter and extends the microbial metabolism by increasing their population. During this process, the important plant nutrients such as nitrogen, potassium, phosphorus and calcium present in the feed material are converted through microbial action into forms that are much more soluble and biologically available to the plants. The treated water is almost disinfected during the process. Earthworms hosts millions of decomposer microbes in their gut and excrete them in soil along with nutrients nitrogen and phosphorus in their excreta. Since the intestine of earthworms harbor wide range of microorganisms, enzymes hormones, etc., this half-digested substrate decomposes rapidly and transformed into a form of vermin-compost within a short time.

Effluent resulted will be extremely rich in nutrition and can be reused as earthworms are versatile waste eaters and decomposers. It also grinds, aerate, crush, degrade the chemicals and act as biological stimulator. Microbial and vermi processes will simultaneously work by treating the wastewater using earthworms. Microbial activity will be stimulated and accelerated by earthworms through developed aeration and also by improve the soil microbe population [4]. This treatment has additional advantage as absence of sludge formation compared to conventional treatment. Vermitechnology is found to be suitable for decentralized treatment of wastewater. Diverse experiments had been carried out on vermin-filtration and found it highly efficient in removing Chemical oxygen demand (COD), Biochemical oxygen demand (BOD) and suspended solid (SS) and some N and P.

MATERIALS AND METHODS

A small scale Bio-filter plant was set up for treating of 30 m^3/day of domestic wastewater in the campus of Gharda Institute of Technology, by M/s Transchem Agritech Ltd, Vadodara, Gujrat. Figure 1 shows the schematic diagram of Bio-filter plant. The size of the bio-filter plant is 9 m x 5 m x 1.75 m. At the bottom of the plant the earth soil is rammed well and 100 mm PCC and 150 mm RCC bed is layered above the soil. The bottommost layer is made of gravel aggregates (rubbles) of size 75–100 mm. The depth of the layer is 300 mm, above this lay the aggregates of 40 to 60 cm sizes filled up to another 400 mm. On the top of this is the 350 mm layer of aggregates of 8-10 mm sizes mixed with sand. The topmost layer of about 650 mm is Bio-filter media which consists of pure soil and wooden chips along with cow dung in which the earthworms are released.

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 hundred to several thousands. There are reports about 8000 numbers of worms per square meter of the worm bed and in quality (biomass) as 10 kg per m^3 of soil for optimal function [5].

WATER SAMPLING AND ANALYSIS

The Bio-filter plant was put into operation in third week of January 2014. The sewage water from the residential building is collected in the underground tank. The influent water is uniformly distributed by sprinklers over the bed of the bio-filter. The wastewater is percolated down through various layers in the bio-filter passing through the soil layer inhabited by earthworms, the sandy layer, and the gravels and at the end was collected from the bottom of the system.

Influent and effluent samples are being collected once in a week. After measuring temperature and pH, samples are analyzed for Dissolved Oxygen, Chemical Oxygen Demand (COD), three-day Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS) according to the American Public Health Authority (APHA 2005).

RESULT AND DISCUSSION

Influent and effluent samples collected for the period Jan 2014 to Jun 2014 are considered for evaluation of Bio-filter performance.

The characteristic of influent is as given in Table 1.

S N	Parameter	Value
1	Odor	Unpleasant
2	Temperature	30 – 35 ^{0}C
3	pH	7.0 – 7.8
4	Total Dissolved Solids	129 – 289 ppm
5	Dissolved Oxygen (DO)	5.6 – 8.0 ppm
6	Biological Oxygen Demand (BOD)	10 – 95 ppm
7	Chemical Oxygen Demand (COD)	114 – 382 ppm

pH:

Results indicate that the average value of pH of the treated wastewater is 7.42. The effluent is neutralized by the earthworms in the bio-filter plant.

The temperature of the treated wastewater ranged from 28 to 34 ^{0}C.

Total Dissolved Solids (TDS):

Fig 1 shows the TDS values of influent and effluent of plant. Total dissolved solids in the effluent were reduced and ranged from 40 to 228 ppm. On an average, the percentage reduction in TDS is 15.42 %.

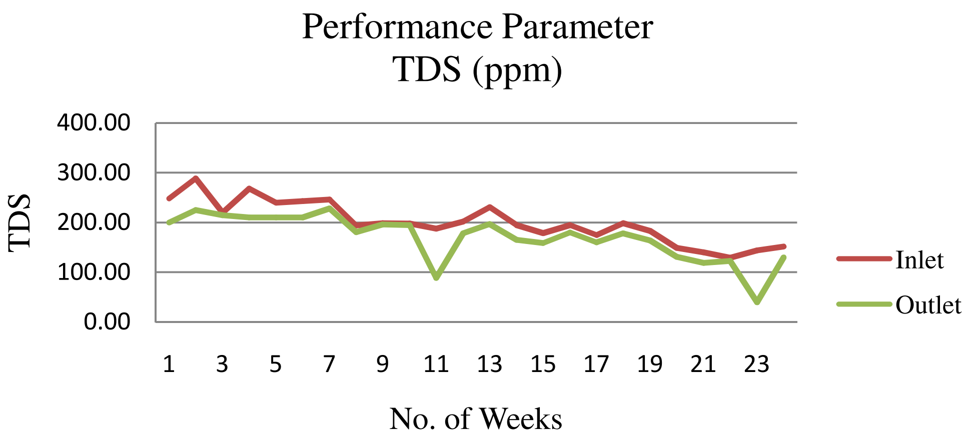

Fig 1. The graph is of TDS v/s Number of weeks

Results thus clearly suggested the capability of earthworms to remove solid fractions of wastewater during vermi-biofiltration processes.

Biological Oxygen Demand (BOD)

Fig 2 shows the BOD values of influent and effluent of plant. BOD is an important indicator of organic load of wastewater.

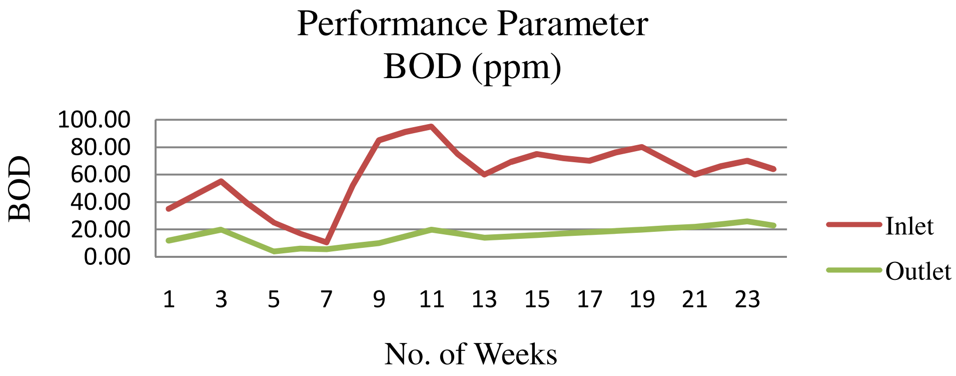

Fig 2. The graph is of BOD v/s Number of weeks

The BOD load in effluents from the bio-filter was significantly lower than the influent levels. It can be seen that the percentage of reduction in concentration of BOD in the bio-filter ranges from 46.67 to 88.24 %. The earthworm degrades the wastewater organic by 'enzymatic action' (which work as biological bringing the pace and rapidity in biochemical reaction) and that is the reason for BOD removal in vermifilter.

Chemical Oxygen Demand (COD)

It can be seen from figure 3 that percentage of reduction in concentration of COD in bio-filter ranges from 36.84 to 85.71 %.

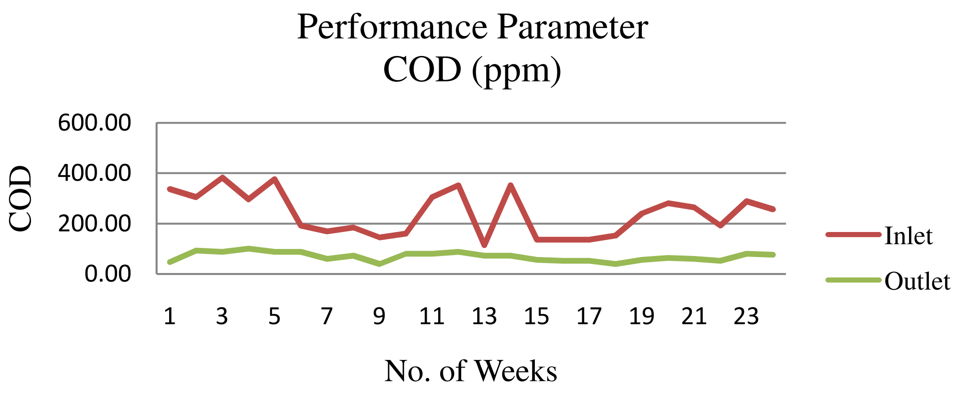

Fig 3. The graph is of COD v/s Number of weeks

Earthworms secrete the enzyme that helps in the degradation of several other chemical which cannot be decomposed by microbes.

CONCLUSION

Vermifiltration is a logical extension of soil filtration which has been used for sewage treatment. From the data obtained, it was found that vermifilter is efficient for the removal of BOD, COD as well as solids. When compared to the acceptable value for BOD in treated waste water is 1-15mg/l, COD is 40-70mg/l and pH is 7.0. The values obtained from the experimental are well within the limits, shows vermifiltration system has good performance in treatment of sewage water. Reduction of sewage water characteristic was greatly facilitated by addition of sawdust to the soil, which could enhance the porosity of soil. The earthworm production, growth, breed & survive in the moist environment is very well was observed during the process of experiment. The advantages of this plant are simple and easy operation, low operating and maintenance cost, low energy input, no sludge formation; treated water is nutrient rich and natural way of fertigation for better agricultural production and cost saving fertilizer. This process is aerobic and hygienic, hence no odour.

Results of vermifilter technology are most cost effective, odor free for treatment with efficiency, economy and potential decentralization.

REFERENCES

[1] Amarasinghe, U.A.; Shah, T.; Turral, H.; Anand, B.K., 2007. India's water future to 2025-2050: Business-as-usual scenario and deviations. Colombo, Sri Lanka: International Water Management Institute (IWMI). (IWMI Research Report 123).

[2] (MoEF 2009) http://www.moef.nic.in/downloads/home/home-SoE-Report-2009.

[3] Metcalf, Eddy, Wastewater Treatment Engineering, Tata McGraw Hill publications, New York, 2003.

[4] R.K. Sinha, G Bharambe, U Chaudhari, Sewage treatment by vermifiltration with synchronous treatment of sludge by earthworm: a low-cost sustainable technology over conventional systems with potential for decentralization, Environmentalist, 28 (2008) 409.

[5] Sinha R.K., Bharambe G., Bapat P "Removal Of High BOD And COD Loading Of Primary Liquid Waste Product From Dairy Industry By Vermifiltration Technology Using Earthworm" Indian Journal of Environmental Protection, Vol 27, No. 6 June 2007.