Recycling of Waste Water by Using Vemifilter

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ABSTRACT:

Vermifiltration is a well-known biotechnological aerobic process of treatment of wastewater which is carried out with the use of epigenic earthworms as a means of treating wastewater and it has been increasingly regarded as an environmental friendly wastewater treatment technique. In the present work, treatment of domestic wastewater was performed using the species of Eisenia fetida earthworm to achieve the requisite quality of the effluent. The study included evaluation of performance efficiencies of vermifiltration system based on various parameters like pH, temperature, EC, DO, salinity, BOD, COD, phosphate, sulphate, nitrate and also the pathogen removal efficiencies for total coliform and faecal coliform. The study of five month study revealed that presence of earthworm in the vermifilter bed can efficiently remove BOD and COD by 83.51 % and 83.33% respectively. About 90-99% pathogen removal efficiency was observed for total coliform and faecal coliform which shows that Verm filtered water can be reused for non-potable purposes like irrigation, gardening, industrial etc.

INTRODUCTION

Now a days scarcity of water is one of the major issues of the present world due to growing demands of water. It has been reported that about 80% of the water supply used by the society returns as domestic wastewater in the sewer system. In most cases, huge amount of diverse nature of effluents released from varied industries are disposed in open environment causing pollution of soil and water resources. Individual wastewater treatment through physical, chemical or biological method is often very costly and results in a large amount of sludge. Thus there is a need to look for an alternative treatment process. Efforts are ongoing in order to develop new sustainable, low cost technologies for the treatment of wastewater. Various technologies for wastewater treatments have been extensively investigated. Many onsite treatment technologies such as the septic tanks, aerobic biological treatment units, fixed activated sludge treatments, constructed wetlands, soil infiltration trenches, vegetation based wastewater treatment, bioremediation through plants etc. are functioning and effective in removing the pollutants. Even though most of the wastewater treatment plants are designed efficiently to remove organic pollutants and nutrients but rarely have designed specifically to remove pathogenic microorganisms from wastewater. However, these technologies are restricted to use because at times these are prone to failure due to high capital, operational and maintenance costs that are not affordable for developing countries and needs large capital investments. The operational and maintenance problems in wastewater treatment may be due to mechanical failures or system failures from inappropriate design. Biological inhibition is a common type of failure. Therefore an alternative onsite wastewater treatment process is needed to seek that is economically affordable, environmentally sustainable and socially acceptable. Wastewater recycling is an attractive option. Wastewater treatment can be tailored to meet the water quality requirements for a planned reuse which includes the treatment of wastewater in an environmentally sound manner and economical effective manner. The reuse of wastewater for non-portable water application is a potential solution for water deprived regions of the world

OBJECTIVES

The objective of the vermifilter project is to provide decentralised, ecological water waste treatment for use in rural communities, as well as potentially being rolled out to industrial such as agricultural and aquaculture.

METHODOLOGY

Wastewater contains large fractions of organic as well as inorganic components which must be treated before it is dispose of in order to protect the environment as well as health of living organisms. Keeping this concern in mind, a wastewater treatment plant was setup at the institute

campus. A large storage tank of 500 L capacity was installed which finds its way to overhead tank of 300 L capacity with continuous agitation. The wastewater gets collected and stored first in the 500 L capacity large storage tank. Then it is pumped in to overhead tank of 300 L tank, where a continuous agitation was provided for proper mixing of wastewater which avoids the settling of organic waste at the bottom of the tank.

Figure 1: Vermifilter plant at the campus of Dr. B. Lal Institute of Biotechnology, Jaipur The treatment of the wastewater was accomplished with the different layers in the vermifilter reactor. The vermifilter bed comprises of 5 layers (total depth-100cm) of packed filter media of different sizes of gravels and vermicompost layer. At the top, an empty space of 10 cm is provided for aeration. Also at bottom, an empty space of 10 cm is provided for collection of the effluent samples. The first layer comprises of mature vermigratings (earthworm & vermicompost) of 30 cm depth in which the earthworm species of Eisenia fetida were inoculated with stocking density of 10,000 worms/m2 . The second layer comprises of 2-4 mm fine gravel size with 15 cm depth followed by third layer of 6-8 mm medium gravel size with 15cm depth. The fourth layer comprises of large gravel with 20 cm depth. The wastewater was collected from the institution campus itself. The wastewater was introduced in to the vermifilter system through perforated PVC pipes of 1.5 mm diameter with hydraulic loading rate of 1m3 /m3 /day. The experiments were performed during the month of March 2017 through June 2017. Initially, 15 days were considered as acclimatization period for earthworms to adjust to the new surrounding environment. The starting of the vermifiltration process was initiated by seeding wastewater in batch mode for 3 hrs/day and later after acclimation and configuration the hydraulic retention time was found to be 8 hrs/day at room temperature. After the designing and construction of the vermifilter, the performance efficiency of vermifilter was evaluated for treatment of domestic wastewater. Grab sampling technique was adopted throughout the research study continuously. The sampling was done once in a week. The samples were taken directly for analysis of physico-chemical parameters. Later microbiological work was also carried out as soon as possible within 24 hrs. The samples were stored in refrigeration at 40C to avoid any changes in its properties during the experiment. The concentration of BOD, COD, TDS, EC, DO, pH, temperature, Salinity, Phosphate, Sulphate, Nitrates in the wastewater before and after were determined

The Vermifilter and the Formation of Vermifilter Bed

The assembly of vermifilter is composed of HDPE container – a market ready Sintex® (CCWS 150.01) tank of capacity of 1500 lit. The present model has been designed so as to treat 400 liters of wastewater per day. This reactor as a Vermifiltration unit of 1350 mm in diameter 1265 mm in depth has been designed. The depth of 1265 mm has been divided into 4 parts in which gravel, sand and soil bed for earthworm were placed from bottom layer to top. The assembly consist about 35 kg of gravels with a layer of garden soil on top. The proper mixture of garden soil and sawdust at a volume ratio of 3:1 has been adopted- forms vermifilter bed. The system has provisions to collect the filtered water at the bottom which opens out through a pipe fitted with tap. The system consists of bottommost layer and was made of gravel aggregates of size 16-20 mm and it fills up to the depth of 20 cm. Above this lies the aggregates of 10 mm sizes filling up to another 20 cm. On the top of this, 20 cm layer of 5 mm aggregates mixed with sand. The topmost layer of about 20 cm consists of soil bed in which the earthworms were released. The inoculated earthworms i.e., Indian blue worms was at an initial earthworm density of 75 gm. The worms were given around one week settling time in the soil bed to acclimatize in the new environment. A cylinder shaped vermifilter that was naturally ventilated was equipped with a 16mm polypropylene pipe with holes to ensure uniform distribution of the influent and a set of pipes inserted to provide aeration. A wire net was placed below the layer of soil bed to allow only water to trickle down while holding the earthworms in the soil bed because it can crawl down to filter materials.

RELATED WORK

According to earlier reports, vermifiltration technology have been extensively studied due to its effectiveness in removing pollutants from wastewater and its positive effects on the environment (Natarajan et al., 2015). Vermifiltration is a relatively new technology which can process organically polluted wastewater using earthworms. In this technology the microbes play an important role in vermifiltration system and they also provide some extracellular enzymes to facilitate the earthworm for rapid degradation of organic substances in vermifilter bed (Tomar and Suthar, 2011). With its increasing removal efficiency in treatment of wastewater, vermifiltration is also finding application in treatment of dairy industry liquid wastes. Dairy industry generates large amount of white turbid liquid waste products which contain high organic matter which cannot be processed further in the industry and hence has to be discarded (Sinha et al., 2006). In a study by Arora and Kazmi (2015), they explored the effects of seasonal temperature on the treatment efficiency and pathogen removal efficiency. Higher BOD & COD removal was reported to accomplish during summer and autumn period with mean temperature of 25-27˚ C. In another study by Arora et al., 2016 (a), they investigated the performance of the reactor and pathogen removal efficiency during wastewater treatment by vermifiltration. Vermifiltration showed a greater potential for chemical pollutants and pathogen removal from wastewater. Higher percentage of BOD, COD, TSS, FC, FS, Salmonella and Escherichia coli removal was observed to the accepted level for reuse in irrigation purpose. III. MECHANISM INVOLVED Earthworms act as an aerator, grinder, crusher, chemical degrader and a biological stimulator and degrade waste by multiple actions. Vermifiltration is a natural engineered system in which the wastewater is treated by using the potential of earthworms which are capable of degrading the organic fraction of waste present in wastewater. Usually this technology is a modified version of the traditional method of water treatment which finds application in improvement of water quality in bore wells in ancient times. The conventional wastewater treatment can be achieved by three stages primary, secondary and tertiary. In comparison with the conventional treatment system, vermifiltration technology serves as a better alternative as it operates in a single process instead of using three different units in vermifilter and due to its cost effectiveness, vermifiltration technology is an eco-friendly and sustainable technology. Also during vermifiltration, there is no sludge formation and it is an odour-free process and the resulting vermifiltered water was clean enough to be reused for farm irrigation and gardens. Hence vermifiltration is overall a very advantageous technology in comparison to the other conventional technologies. It is a technology to treat wastewater by the great waste manager-the earthworm's species. Earthworms are known as versatile waste eater and decomposers. Their body works as a biofilter which widens the metabolism by increasing their population. There is a symbiotic and synergistic effect between the earthworms and microorganisms which play a crucial role in wastewater treatment. There are millions of microorganisms that are present inside the earthworm which helps in biochemical degradation of organic matter present in wastewater. Earthworms degrade and homogenise the organic waste through muscular actions of their foregut and add mucus to the ingested material and make it available for microbial diversity present inside. Inside the gut they show their enzymatic activity in order to degrade the organic waste. These microbial activities will be stimulated and accelerated by earthworms through developed aeration and also by improving the soil microbe population (Sinha et al., 2008). The vermifilter media provide a high specific area for the earthworms to process and stabilise the dissolved, in organics and suspended solids trapped on the top of vermifilter through complex biodegradation process and is fed to the small microbes that are immobilised on vermifilter bed material. This enables the soil stabilization and filtration system to become effective.

FACILITIES AVAILABLE

The following facilities are available at Sahakar Maharshi Shankararao Mohite Patil Institute of Research & Technology, Akluj to carry out dissertation work.

1. Material testing Lab.
2. Online Journals and Library facility.

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