Vermifiltration for Food Processing Industrial Waste Water

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Abstract

Due to the increasing demand of the centralise treatment for the industrial waste water the vermifiltration is an newly developed innovative wastewater treatment technology which implies the use of composting earthworms to treat wastewater loaded with high organic contents. The body of earthworms works as a bio filter and the symbiotic and synergistic interaction of earthworms with microorganisms present in the waste water, is responsible for the treatment of wastewater as it passes through the gut and intestine of worms. It was observed that the vermin filter rector shows the highest reduction rate in BOD, COD, TSS, TDS by 90%, 86%, 75% and 60% respectively. There is not much more changes are observed in pH for vermivermi filter. There is no sludge formation in the vermifiltration technology which requires additional expenditure on land filling and disposal.

Keywords- Vermifiltration, Eisenia Fetida, Food processing effluent, COD, BOD, TSS, TDS.

1. Introduction

Generation of wastewater and its treatment has become a major health problem in the developing countries because of in industrial areas there are insufficient facilities for waste water treatment and also it creates a major environmental impacts by its uncontrolled discharge which is also a concern. The source of contamination of water resources is the discharge of untreated wastewater on surface and sub-surface water courses.

Several technologies which are lower in cost have been checked for potential use in industrial effluent treatment which involves biological, chemical and thermal treatment methods and these technologies have a shortfall. There is strong need to look for affordable and easy to use technologies like the Vermifiltration Tchnology, a low cost and easy to use technology. Presently, for industries, linear waste water disposal systems are followed in ETPs by using the activated sludge (ASP) method. Environmental regulations insist for zero discharge waste water treatment systems, thereby the refinement of conventional treatment technologies and implementation of new technologies for waste water treatment to meet stringent water quality criteria is made mandatory.

Food processing industries is one of the largest industries in India. Indian food industry is poised for huge growth, increasing its contribution to world food trade every year. There are different steps in the food industry system like food production, processing, storage, transportation and marketing. Each step has its own impact on the environment. Food processing can be classified into four major sectors: i.e. meat, poultry & sea food, fruit & vegetable, Dairy & beverages. The wastewaters from food processing industries are increasing day by day because of increasing population and changing lifestyle and habits of people. For sustainable developed environment friendly wastewater treatment is required. Compared to other industrial sectors, food processing industry demands much amount of water, since it is used throughout all plant operations.

Food processing industries have high strength organic and nutrient content and tend to cause serious water contamination if discharged without proper treatment. This wastewater contains high COD that poses a great threat to aquatic environment. Food industry uses huge quantity of water for many purposes, for example as sterile water to produce food, but also in cleaning purposes, for transportation, or refrigeration. Wastewater from food-industry has some particularities compared with municipal wastewater meaning it is organic, rich in nutrients, biodegradable,

nontoxic and can be treated by conventional biological technologies. Food processing wastewater show large variation in BOD/COD, TS , oil and grease, starch, sugar, colour, TN, chloride and sodium etc. Food processing wastewater contains high COD, BOD, TSS and TDS.

Vermifiltration using earthworms is a newly conceived novel technology for treating waste water with several advantages over the conventional systems. The wastewater solids are biodegraded by earthworms to humus material. This system will separate the wastewater solids by allowing wastewater to pass through the conventional filtration bed. A vermifilter (also called vermi-digester) is an aerobic treatment system, which consist of a biological reactor containing media that filters organic material from wastewater. This filtration media also provides a habitat for aerobic bacteria and composting earthworms that produce humus. The "Trickling action" of the wastewater through the media dissolves oxygen into the wastewater. This is an important feature because bacteria and worms need oxygen to survive to decompose organic substances. Vermifiltration is a technology in which the combined action of earthworms' activity and the adsorption properties of soil, sand and gravel particles on the organic pollutants are applied to treat the wastewater.Body of Earthworms works as a 'bio filter' and it have been found that it can remove the BOD , COD , total dissolved solids (TDS) , and the total suspended solids (TSS) from wastewater.

2. Materials and methods

2.1 Materials Used

Vermifiltration for food processing industrial waste water was conducted in a filter bed with 13.9 cm radius and 31 cm overall height with 7 cm free space. The food processing industrial waste water was obtained from the industry around 50L. The verfiltration bed was made up of different size of gravels, sand, saw dust, a sprinkler, garden soil, cow dung and earth worms. The earth worms, Eisenia Fetida were used based on 5000-10000 worms/m². Temperature in the vermifiltrationbed was operated under standard conditions with temperature assuming to be ranging between 25 ± 1 ^{0}C.

2.2 Raw Food Processing Industrial Waste Water Characteristics

The food processing effluent was characterized by high COD values (4600-4800mg/L), high BOD values (850-950mg/L) and high TDS (1800-2000mg/L). These characteristics made vermifiltration an interesting option for the food processing effluent treatment. A summary of the characteristics of the wastewater are shown in Table 1.

Parameter	Values
Odour	Unpleasant
pH	6.4-8.1
BOD	800-950mg/L
COD	4200-4800mg/L
TSS	1650-2000mg/L
TDS	1800-2000mg/L

Table: Characteristics of water

2.3 Preparation Of Vermifilter Bed

Different five layes of vermifiltration bed was made in a 20L of tank. From the bottom to top first layer was made of large size gravel of 40mm upto 4-5 cm, above this another layer of aggregate of 25-30mm size was made upto 3-4 cm. Third layer was made of saw dust upto 4 cm and above that sand layer was made upto 3-4 cm. The top layer was made of garden soil, cowdung and earth worms (Eisenia Fetida) upto 7-8 cm. free board was given uptp 7 cm.

2.4 Experimental Setup

Waste water was kept in the first tank (storage) at elevated hight so that the water can flow by the gravitational force to the vermifiltration bed. Waste water was sprinkled to the vermifiltration at the rate of 1.6 L/hr to the top most layer containing worms which was prevented from direct exposure to sun. The wastewater percolated down through the different layers of the vermifiltration bed. From the bottom most layer the treated waste water was collected after the

detention period of 8 hr. This collected treated wastewater were analysed for the parameters pH, BOD5, COD, TSS and TDS.

Figure: Filtration and sprinkler setup

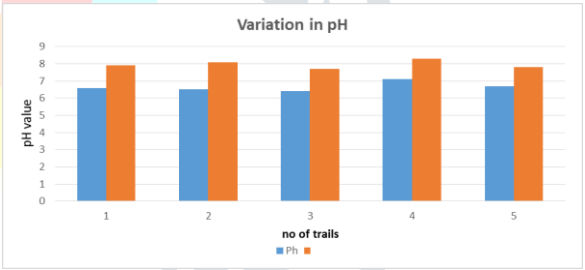
3. Results and Discussion

3.1 Variation in pH

No considerable variations were observed between vermi treated wastewater and untreated food processing wastewater. The graph.1 shows an increase in pH of effluent but within limit.

No of trials	Influent pH	Effluent pH
1	6.6	7.9
2	6.5	8.1
3	6.4	7.7
4	7.1	8.3
5	6.7	7.8

Table No: 1.0



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3.2 Effect on BOD

BOD describes the amount of dissolved oxygen essential to breakdown organic contaminants through aerobic bacteria As the vermifiltration process occurs, the earthworms feed on the bio contaminants in the wastewater effectively lowering the BOD concentration. The maximum BOD reduction in vermifiltration is about 91%. The percentage reduction in BOD for trial no 1 to trial no 5 are 85%, 87%, 90%, 91%, 91% respectively. Since the earthworms are primarily accountable to biodegrade waste as compared to inorganic waste through enzyme as a biocatalysts to quicker the rate of biochemical reaction, BOD removal efficiency was found to be much better than that of COD removal efficiency in vermifilter.

No of trials	Influent BOD(mg/L)	Effluent BOD(mg/L)
1	820	123
2	900	117
3	850	85
4	875	78.5
5	930	83.7

Table No:1.1

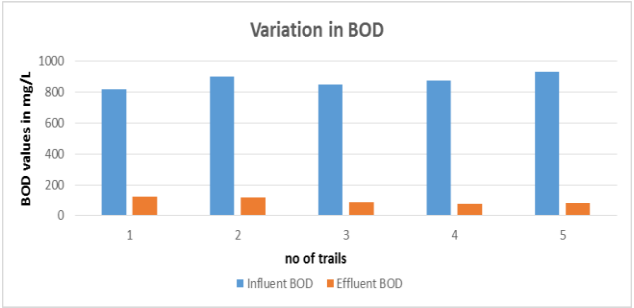

Figure No: 1.1

3.3 Effect on COD

The decrease in the COD was attributed to both the decrease in the bio contaminants due to ingestion by earthworms during vermifiltration which has potential to effectively lower the COD. The chemical decomposition of organic and inorganic contaminants in wastewater which cannot be biologically removed is term as COD. The maximum COD reduction in vermifiltration is about 85%. The percentage reduction in COD for trial no 1 to trial no 5 are 81%, 83%, 85%, 85%, 86% respectively.

No of trials	Influent BOD(mg/L)	Effluent BOD(mg/L)
1	4220	801.8
2	4506	766
3	4770	715.5
4	4630	694.5
5	4710	660

Table No: 1.2

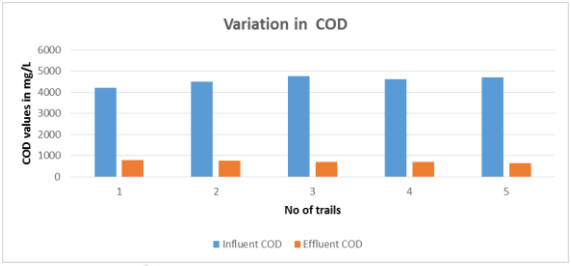

Figure No:1.2

3.4 Effect on TSS

The earthworms provided a bio filtration mechanism during the wastewater treatment period which allowed the total suspended solids to accumulate on the vermifilter thereby reducing the TSS concentration in the Food processing wastewater and later converted to vermicompost. The maximum TSS reduction in vermifiltration is about 75%. The percentage reduction in TSS for trial no 1 to trial no 5 are 72%, 73%, 74.5%, 75%, 75% respectively.

No of trials	Influent TSS(mg/L)	Effluent TSS(mg/L)
1	1675	301.5
2	1890	321.75
3	1995	310
4	1720	258
5	1910	286

Table No: 1.3

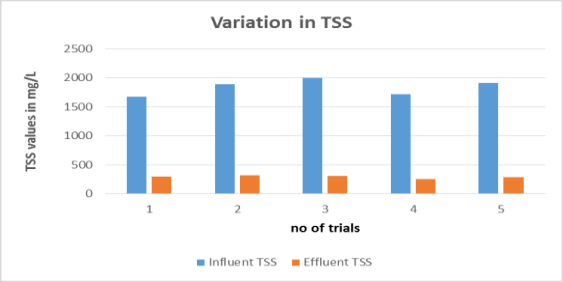

Figure No: 1.3

3.5 Effect on TDS

There is potential for the TDS to accumulate in the vermifilter during the vermifiltration process resulting in decreased TDS concentrations. The maximum TSS reduction in vermifiltration is about 60%. The percentage reduction in TSS for trial no 1 to trial no 5 are 50%, 54%, 55%, 60%, 60% respectively.

No of trials	Influent TDS(mg/L)	Effluent TDS(mg/L)
1	1760	880
2	1900	874.35
3	1920	864.9
4	1800	720
5	1880	752.1

Table No: 1.4

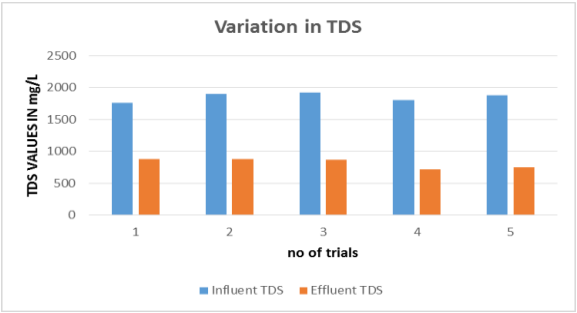

Figure No:1.4

4. Conclusion

Results shows that the vermifiltration showed good efficiency for food processing industry which has solids contents and higher organic loading in pH Range of 6-8.5.The vermifilter treatment was odour free with the good efficiency of removal of parameters, BOD,COD,TSS and TDS. . Results shows that the vermi filter rector shows the highest reduction rate in BOD, COD, TSS, TDS by 90%, 86%, 75% and 60% respectively for 8 hr retention time period. There is no sludge formation in this process instead of that vermi compost was formed which can be used as fertilizer. The vermifiltered water is most suitable for irrigation purpose but would require further treatment for other uses.

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