Domestic wastewater treatment by soil biotechnology

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ABSTRACT

Soil biotechnology (SBT) is a modern technology to treat the wastewater effectively, less costly, eco-friendly which uses the granular media like soil, gravels and sand, biological media like earthworms, bacteria and plants. This technology is useful where there is no sewer transportation is available. In this project I used alluvial soil, E-fetida earthworms and aloe vera plant to treat domestic wastewater of Shertha village, Gandhinagar. Analysis of the domestic wastewater and treated water is being done by IS: 3025 methods and the parameters are pH, TDS, TSS, BOD, COD and Ammonical Nitrogen. Experiments done on different intervals with HRT of 6, 8, 10 hours. As per results the range of percentage removal efficiency of TDS, TSS, BOD, COD and Ammonical Nitrogen are 65-75%, 64-74%, 75-90%, 75-92%, 55-65% respectively. Domestic wastewater is collected from open drainage of Shertha village near kalol, Gandhinagar. Treated water by SBT plant meets the discharge norms of pollution control board. There are no moving parts except the pump so, noise pollution is eliminated.

Keyword: - *Soil biotechnology (SBT); HRT; Earthworms; Constructed wetland (CW); COD;*

1. INTRODUCTION

Biotechnology Definition: It is the use of living system and organization to make technological application that uses biological system.

Environmental biotechnology can simply be described as "The optimal use of nature, in the form of plants, animals, bacteria, fungi and algae, to produce renewable energy, food and nutrients in a synergistic integrated cycle of profit making processes where the waste of each process becomes the feedstock for another process"

Generally, the wastewater discharged from domestic premises like residences, institutions, and commercial establishments is termed as “Sewage / Community wastewater”. It comprises of 99.9% water and 0.1% solids and is organic because it consists of carbon compounds like human waste, paper, vegetable matter etc. Besides community wastewater / sewage, there is industrial wastewater in the region.

Earth has got only 2.5% of fresh water out of which only 0.01% can be accessed by humans as the rest is frozen as glaciers and ice bergs. India is blessed to have 10 major river systems namely Indus, Ganga, Yamuna, Brahmaputra, Tapi, Godavari, Narmada, Krishna, Kaveri and Mahanadi. Out of it, a major issue of concern is with river Yamuna which has a stretch of 1367 km before it merges with river Ganga in Allahabad. The river extends in the states of Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh and the entire union territory of Delhi. Only 2% of Yamuna flows through Delhi but on the contrary the capital contributes its 70% pollution load. Although the rivers have a mechanism to self-purify but the rate at which a river can purify is much less than the rate at which it being polluted and the way it is being polluted is also a matter of concern.

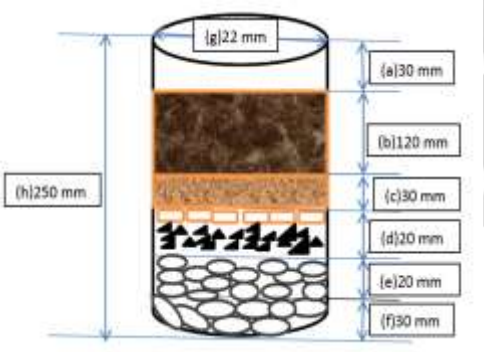
Hence water recycling has now become a compulsory vertical to run a civilization efficiently.

SBT is a wastewater treatment process, which is based on a bio-conversion process where fundamental reactions of nature, namely respiration, photosynthesis and mineral weathering take place in a media housing micro & macro organisms which bring about the desired purification. SBT is an oxygen supplying biological engine and so the process can treat all types of water – domestic, municipal and industrial.

Soil Biotechnology (SBT) used as an option for decentralized wastewater treatment. The current sanitation scenario of urban India is one of severe lack of collection, treatment and disposal systems for domestic sewage. In order to tackle this problem and protect water resources from contamination, while also augmenting usable water resources, there is an urgent requirement to identify appropriate technologies for wastewater treatment. Decentralized technologies are increasingly attractive because of several advantages, especially in the Indian context.

2. MATERIAL AND METHOD

From different research papers I found different material used in the treatment of soil biotechnology. Different sized gravels, aggregate and sand is used as granular media. Earthworm, Bacteria, fungi etc. used as per specific removal of impurities. Plantation as well as hydraulic retention time plays important role in the removal of impurities.
According to different author size of the tank has been design by them were different from each other because of variation in quantity of water to be treated. Many researchers construct a settling tank before the soil based reactor to increase the removal efficiency of suspended and dissolved solids.
According to S.M.Patnaik, 30% soil and 70% granular media is being used in this technology [5].
Various types of vegetation or plants were available for treatment.
Typha latifolia, Phragmites carca [4][5], Potamogeton crispus, Hydrilla verticillata [1], Canna hybrid, Strelitzia reginae [9] etc.
According to Himanshu Gupta and Dr. D.S.Vyas Eisenia Fetida earthworm is best in the removal of organic matter present in the domestic wastewater [8][5].
In the reactor gravels is being placed at the bottom and then aggregates of different size, sand and soil placed accordingly.
Size of the gravels and sand is varies from plant to plant.
In this research paper three layers of different sized gravels, 40-50mm, 20-35mm and bricks were introduced in reactor. 2.3mm sized sand was used and 200 Eisenia Fetida earthworm used in reactor for treatment of domestic wastewater.



The depths of the layers were 30, 20, 20 and 30mm respectively.
Where,

(a) 30mm = free board area
(b) 120mm = soil area
(c) 30mm = 2.3mm sand
(d) 20mm = brick and 10-20mm gravels
(e) 20mm = 30-35mm gravels
(f) 30mm = 40-50mm gravels
(g) 22mm = radius of the container
(h) 250mm = height of the container

Hydraulic retention time plays important role in removal of impurities form wastewater.
The time of flow of wastewater or effluent through the vermifiltration unit is called as Hydraulic retention time (H.R.T). In order to purify the effluent should remain inside the vermifiltration unit for certain period of time.

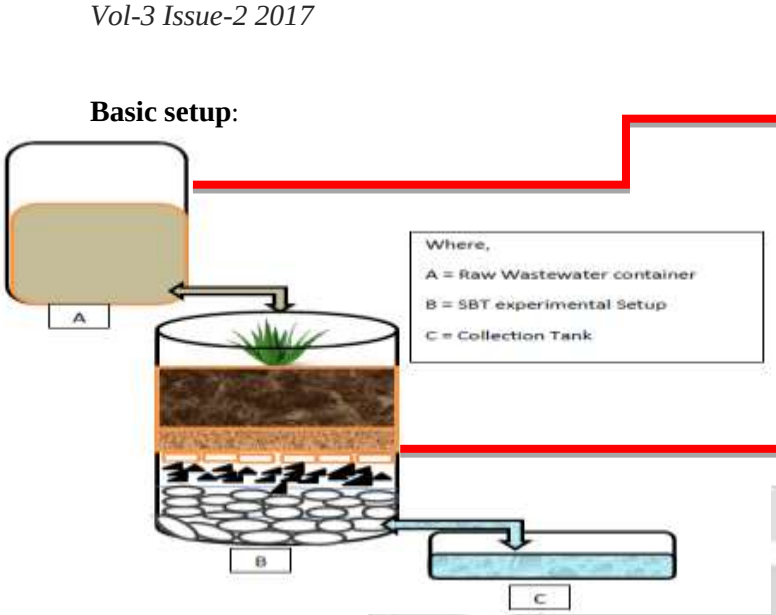
$$H.R.T = V/Q$$

Where, V= volume of tank and Q= Flow rate.
The Hydraulic Loading Rate (H.L.R.) is the volume of wastewater or effluent that loaded to the SBT which can be purified to a reasonable extent in a given time.

$$H.L.R = V/ (A \times t)$$

Where, v = volume of the tank, A= area of soil profile and t= time taken by effluent to pass through soil [7].

Basic setup:



Procedure:
First of all raw wastewater is drown from the settling tank to remove suspended solids then drown into soil filter.
Wastewater is passed by piping with Hydraulic retention time of 6, 8 and 10 hours.
Purification of wastewater takes place by filtration, adsorption, photosynthesis, nitrification, Denitrification and mineral weathering [6].
Treated water is being collected from collection system at bottom.
Treated water can be used for ground water recharging, car/vehicle washes, gardening, toilet uses or other irrigation purpose [7].

3. PARAMETERS AFFECTING

1. Seasonal variation

Reduction of nutrient concentrations in a wetland is mainly by biotic, temperature-dependent activity. The efficiency of treatment in a constructed wetland decreases at low temperature primarily because of reduced biotic activity [3].

COD removal was more efficient in the spring and summer than in autumn and winter, whereas NH4-N and TP removal was more efficient in summer for NH4-N and for TP and autumn for NH4-N and then in spring for NH4-N and for TP and winter for NH4-N and for TP [2].

2. Plantation

Plantation is oxygen supplying tool for the treatment. Because of photosynthesis plants supply the oxygen to bacteria or earthworm present in the soil. It was observed by treating waste water by planted and unplanted constructed wetland and higher removal rate found in planted constructed wetland [1].

3. Earthworms

Earthworm body works a biofilter which widens the microbial metabolism by increasing their population. It also grinds, aerate, crush, degrade the chemicals and act as biological stimulator. Among all earthworms E.Fetida is best suited for treatment of waste water from different fields [8].

4. Hydraulic retention time

Performance of the reactor is depends on the retention time. If HRT increase, the removal efficiency increases too [1][9].

4. Results

1. Method of the analysis of waste and treated water is:

SR NO.	Parameter	Method No.
1	pH	IS 3025 PART-11
2	TDS	IS 3025: PART-15
3	TSS	IS 3025: PART-15
4	BOD	IS 3025: PART-44
5	COD	IS 3025: PART-58
6	Ammonical Nitrogen	IS 3025: PART-34

2. Domestic wastewater and % removal of impurities range in inlet [Lab analysis]

SR. No	**Parameter**	**Domestic wastewater Range (inlet)**	**% Removal at 6 hr HRT (%)**	**% Removal at 8 hr HRT (%)**	**% Removal at 10 hr HRT (%)**
1	pH	7.6-8.8	---	---	---
2	TDS mg/L	700-850	60-65	64-69	75-80
3	TSS mg/L	150-250	64-70	74-80	78-85
4	BOD mg/L	70-140	65-72	75-80	85-93
5	COD mg/L	250-350	70-75	74-82	80-90
6	Ammonical Nitrogen mg/L	35-45	54-60	58-62	60-65

5. Conclusion

Results show that soil biotechnology achieves good performance in the removal of the impurities. The treatment was cost effective, odor free, very simple to operate & maintain, does not require skilled man-power, Low energy requirement. Variation in HRT put the great impact on removal efficiency of the treatment plant. Results show that removal efficiency of the plant is maximum at 10 hour retention time. Earthworms also plays role in the removal of organic matter present in the wastewater. I get the maximum removal efficiency in 10 hour retention time. Removal efficiency of TDS, TSS, BOD, COD and Ammonical Nitrogen are 75-80%, 78-85%, 85-93%, 80-90% and 60-65% respectively. The treated water through soil bio technology can be used for Irrigation, groundwater recharging, Industrial process, gardening, flushing, construction, road/car wash etc.

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