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Treatment of Sewage by using Hybrid Technology

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ABSTRACT- Soil biotechnology (SBT) is a green engineering approach for wastewater treatment and recycling. In the present study institutional waste water characterization has been performed followed by the design of Soil Biotechnology plant. Water is a very versatile resource and hence it is used for numerous domestic as well as industrial purposes. As water is a free resource and 70% of earth's surface is covered in water, Man has used it rapidly subsequently contaminating it with domestic as well as industrial wastes. Now, as we understand the importance of water and how we are contaminating it, we know that there is a need to reuse the water again and again so as to ease the pressure on the fresh water available on earth's surface. To reuse the contaminated water, it has to be treated so that the harmful impurities can be separated and removed. Depending upon the quality of waste water, volume of water to be treated and the use of the treated water, number of processes have been developed and implemented. One of such process is known as Soil Bio Technology which is a green technology wherein there is a minimum use of power for treatment without compromising the quality of treated water. The waste water is first passed through tube settlers and then through Tanks known as Bio-Reactors which are filled with Aggregates, Brick Bats and Bio Media (earthworms). Waste water flows through this layers which acts as filters by gravity and is treated through a natural and harmless process. This process has number of benefits over the conventional processes but also has its own limitations. 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 paper 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.

KEYWORDS- Soil Biotechnology (SBT), Sewage, Earthworms, BOD, COD, TDS, TSS

I. INTRODUCTION

SBT is a hybrid 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.

Constructed soil filter (CSF) also known as Soil Biotechnology (SBT) is a process for water renovation which makes use of formulated media with culture of soil macro- and microorganisms. CSF combines sedimentation, infiltration and biodegradation processes to remove oxidizable organics and inorganics of wastewater in a single facility.

The SBT system was developed after two decades of research by Prof. H.S. Shankar and associates at the Chemical Engineering Department of Indian Institute of Technology (IIT), Bombay. Following this development, Prof. Shankar founded Vision Earthcare, a company which seeks to provide wastewater treatment solutions using this technology. Other service providers have also licensed this technology.

"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." (Vision Earthcare, 2013).

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| Volume 10, Issue 6, June 2023 |

Since then, SBT has been installed in more than 20 locations, treating wastewater volumes between 5-10 MLD in industries, housing societies, resorts, schools, universities, ashrams, hotels and municipal corporations. As explained by a patent document and other research papers produced by the research group at IIT (IIT Bombay, 2003; Kadam et al., 2008; Kadam et al., 2009), SBT incorporates the use of specific micro-organisms.

These are part of the process that cleans organic waste through oxidation and releases carbon dioxide. Nitrification followed by de-nitrification convert the nitrogen load in the wastewater to elemental nitrogen gas. Primary minerals, which form the base media in the bioreactors within which the purification processes take place, create a pH buffering effect. Whilst earthworms serve to aerate and regulate bacterial populations, trees and shrubs planted on the surface of the bioreactor act as bio-indicators to signal a properly functioning plant.

The physical (civil) structures consist of a raw water tank, a bioreactor containment structure, a treated water tank and associated piping, pumps and electrical installations. The process is meant to handle domestic sewage and industrial sewage containing primarily organic effluent. Treated water quality of various levels can be obtained, from river discharge quality up to near drinking-water quality, from an SBT depending on the requirement and investment potential.

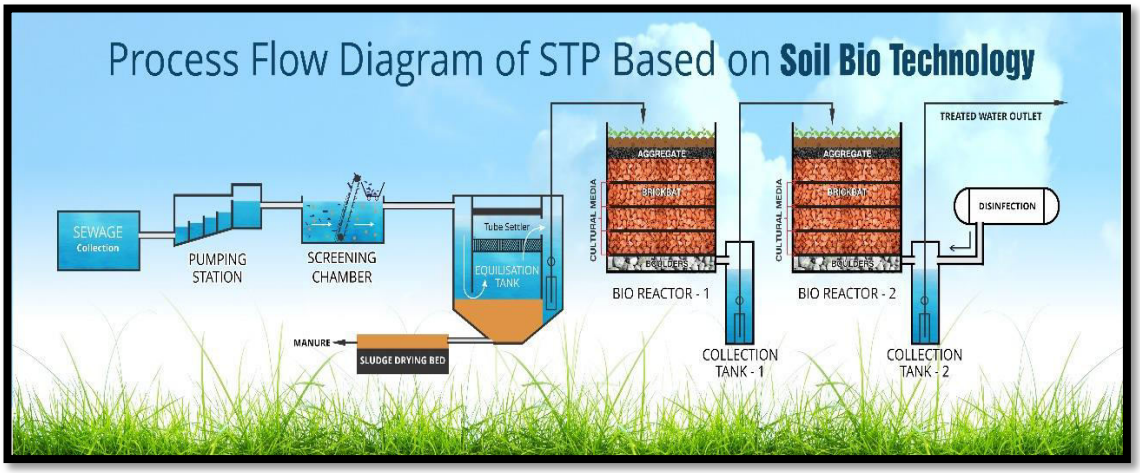

Fig.1.1: Process Flow Diagram SBT

OBJECTIVES:

The SBT system is applicable for water purification (primary processing prior to disinfection), wastewater purification and air purification. Typical applications include-

(i) Rrainwater harvesting via storm water conservation.
(ii) Primary purification of drinking water.
(iii) Primary purification of swimming pool water.
(iv) Sewage treatment for reuse in construction, cleaning and gardening, make up water for swimming pools and industries, etc.
(v) Industrial wastewater treatment.
(vi) Removal of iron and arsenic from water.
(vii) Industrial air purification via scrubbing the air pollutant with water and then treating the scrubbed water through CSF.
(viii) New applications viz. retrofitting of conventional industrial wastewater treatment plants, biotower for space limiting situations, restoration of polluted water bodies, etc. are new aspects of future application

NEED OF GREEN TECHNOLOGIES:

As the operation of a conventional waste water treatment plant is a very costly affair and require regular maintenance, gradually the quality of treatment deteriorates and the efficiency of the whole plant is jeopardized.

Hence there is a need to study the Green technologies of waste water treatment to reduce operation and maintenance of STP. These Green Technologies should be low-cost method and should also have good degree of treatment as

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| Volume 10, Issue 6, June 2023 |

compared to conventional treatment. One of such Green technology is Soil Bio Technology but it has its own limitations.

NEED & SIGNIFICANCE:

1. Keeping the Environment in perspective, there is a need of a green i.e. natural process for treating waste water with low installation cost as compared to large conventional waste water treatment plants.
2. Civil construction is very basic and simple and involves minimum mechanical and electrical equipment.
3. Operation and maintenance cost is very low.
4. As the process uses minimal external energy, breakdown is very rare and the setup is aesthetically good.
5. The Biomedia i.e. earthworms grow naturally and offer a simple and economic method of wastewater treatment.
6. The treated water can be used for domestic purposes like gardening, curing, washing.
7. It enhances the landscape and gives the site a green appeal.

II. LITERATURE REVIEW

[1] Hybrid constructed wetlands for wastewater treatment: A worldwide review (2012)- The utilization of environmentally friendly and eco-safe wastewater treatment plan is nowadays widespread. This study aimed to assess the potentiality of hybrid constructed wetlands for treating of landfill leachate, river polluted water, domestic, industrial, hospital, runoff and agricultural wastewaters in lab-scale, pilot-scale and full-scale with various configurations. The results revealed that the hybrid constructed wetlands are effective to remove organic matter (BOD5, COD) and suspended solid, while in terms of nutrient removal such as N and P components, the removal efficiencies were depending to system properties and operational condition. Additionally, it is very useful system to remove the heavy metals and pharmaceuticals pollutants from different wastewaters. Combination of constructed wetlands enhances pollutants removal efficiency as hybrid constructed wetlands could cover the limitation of each single constructed wetlands. It could be concluded that the hybrid constructed wetlands ensure a more stable removal rate of pollutants from various wastewaters in comparison with other wastewaters treatment plans.

[2] Application of chemically modified rice husk for the removal of heavy metals from aqueous solution (2010)- The removal efficiency of lead, cadmium and zinc from aqueous solution on adsorption by using rice husk, a non-conventional material in its natural and chemically modified form has been presented in this paper. It has been observed that rate of adsorption is dependent on the nature of the adsorbent, adsorbent dose, particle size of the adsorbent, concentration, pH, contact time, temperature, etc. Under identical experimental condition chemically modified rice husk was found to possess greater adsorption capacity for all metals than untreated rice husk and chemically modified rice husk ash. Chemically modified rice husk could remove 99.8% Pb, 95% Cd and 97% Zn from aqueous solution at room temperature.

[3] Domestic wastewater treatment by soil biotechnology (2017)- 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.

[4] Recent advances on pollutants removal by rice husk as a bio-based adsorbent: A critical review (2019)- Rice husk is an attractive bio-based adsorbent material for pollutant removal since it is one of the low-cost and renewable resources. The objective of this review is to give a summary of the key scientific features related to pollutants removal using rice husk, with a specific emphasis on the effect of factors on adsorption capacity of rice husk. According to the results, rice husk has the removal potential of various pollutants and it can be more used in the wastewater treatment. On the other hand, untreated bio-based adsorbent in large-scale application can usually cause some difficulties and selection of appropriate pretreatment method for rice husk is also one of the major challenges. Therefore, this review studies different pretreatment methods as well as regeneration of adsorbent and the fate of adsorbed contaminants. According to the literature, pretreatment methods increase the rice husk capability and adsorption capacity and the

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| Volume 10, Issue 6, June 2023 |

chemical treatments have been more used than thermal treatments. Also, regeneration of rice husk adsorbent and adsorbed contaminants is applicable. Finally, examples of some applications and possibility of biocatalyst immobilization on the rice husk as a promising approach are presented. Results confirmed that rice husk has an excellent prospective potential for biocatalysts immobilization.

[5] Study of Soil Biotechnology for Waste Water Treatment (2020)- Water is one of the world's most valuable resources, yet it is under constant threat due to climate changes, resulting in drought, explosive population growth, and waste. India is completely dependent on the monsoons to meet its annual water demand. Reclamation and reuse of the Wastewater would help minimize the overall supply of water. The amount of non-potable water generated in the Class 1 Cities has a population of n more than 1 la, is approximately 35,558 Million liters/day. This water goes directly into the septic tanks and becomes Wastewater. SBT involves removing organic matter by adsorption, followed by biological degradation and oxygen supply by natural aeration to the treatment system. The photosynthetic activity of green cover serves as a bio-indicator for the kind of micro-habitat in SBT. The SBT is designed to provide the requisite filtration, aeration, and biochemical processing to remove toxicity, including BOD, COD, nitrate, phosphate, suspended solids, color, odor, and bacteria. Unlike a conventional STP or septic tank where periodically the sludge has to be offloaded, everything is consumed within the plant in this SBT based STP. Raw sewage is pumped to a customized media bed for around five hours (dependent on load and capacity), and clean water flows into the collection tank.

III. PROPOSED METHODOLOGY

The general methodology adapted is summarized below. The samples are collected from various points in college campus i.e from hostels, canteen, mess, college and Architecture College etc. It is important to review the characteristics of waste water to design any kind of treatment facility. The treatment process their duration, efficiency all other factors are depends on the characteristics of an equivalent. After the calculation of observations of various tests performed the results are analyzed with MPCB (Maharashtra pollution Control Board) and CPCB (Central Pollution control Boards) boards. Based on the test results the treatment process is set and therefore the treatment units are designed accordingly.

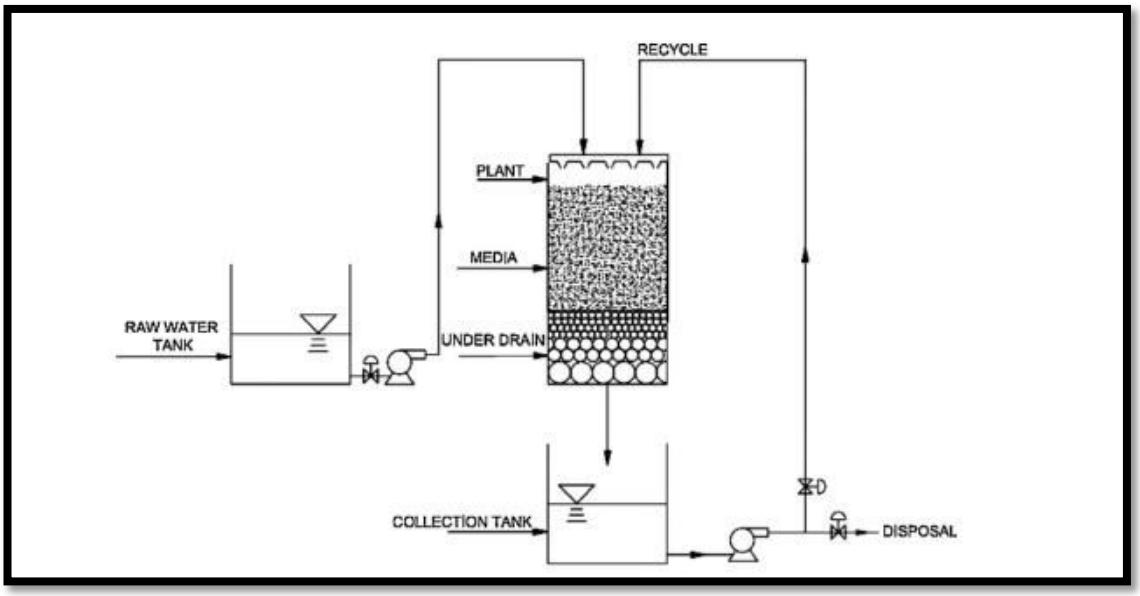

Fig.4.1 : Schematic of SBT process.

4.1.1 Treatment Process

The process can be run in batch mode also as in continuous mode. In above figure, the waste water is firstly come at the screening chamber through a collection pipe. The intake of screening chamber is fitted with coarse screen referred to as bar screen which removes the floating matter and suspended matter sized more than 2cm. Afterwards the mechanical coarse screen removes the fine impurities which wasn't screened through bar screen. The sewage is then transferred towards the sedimentation tank. The detention period is of 4hrs. During this the suspended particles and the other impurities get settled down. This process is done without adding any chemicals into it therefore it is plain sedimentation. The sludge produced is collected and treated for fertilizer production. Then after sedimentation the

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| Volume 10, Issue 6, June 2023 |

water is transferred towards the biotechnology filter through pump. To achieve the natural aeration the water is sprinkled over the plants and soil media over the filter with hydraulic loading typically about 0.04-0.06 m3/m2/h. Now here biological action of bacteria and microorganisms takes place. The water is filtered through this media and picked up in storage tanks near the filter.

The overall duration for operation of treatment process is 4- 6 hrs. The filter bed is then kept in rest for the rested time before the next cycle. In Soil Biotechnology system, problem of clogging is get overcome by propagating soil ecology in place, alternate wetting and drying cycles. During drying cycle, this clogging layer develops cracks due to respiration; so alternate wetting and drying is required for efficient performance.

Factors affecting treatment process of SBT:

1. Seasonal variation: Reduction of nutrient concentrations during a filter is mainly by biotic, temperature-dependent activity. The losses within the treatment process are mainly evapotranspiration and water taken for growth of plants. Therefore the losses are more in summer season than winter.

2. Plantation: Plantation is a crucial tool for functioning of biological activities. It is oxygen supplying tool for the treatment. Because of photosynthesis plants supply the oxygen to bacteria or earthworm present within the soil. treatment. Because of photosynthesis plants supply the oxygen to bacteria or earthworm present within the soil.

4.2 EXPERIMENTAL ANALYSIS

Samples of row waste water were collected in June 2021 and tested. In the present study, tests conducted are pH, turbidity, BOD, DO, solids etc. Conducted tests were performed as per the standard procedures according to IS procedures. Direct measurement of pH of waste water effluent may vary dramatically due to change in temperature, water flow and any substance present in water. Therefore for the accurate measurement of the pH value of waste water, the accurate value of temperature is additionally required. IS recommends standard pH meter, a durable pH electrode, an ATC (automatic temperature compensation) probe, a stirrer with stir bar, 100-mL graduated cylinder, 100-mL beaker, deionized water and buffers. The pH electrode will be exposed to chemical contaminates and particulates; recommend a double junction electrode. The presence of suspended particles in the sample is the turbidity. It is caused due to dissolved impurities in water. Its presence is expressed in parts per million of pure water. This can be found out by the aid of various instruments such as Nephelometric turbidimeter, Jackson's turbidimeter, Turbidity rod, Baylie's turbidimeter, etc. In present study the instrument used is Nephelometric Turbidimeter. Itindicates the presence of turbidity in NTU (Nephelometric Turbidity Unit).

Biochemical Oxygen Demand (BOD):
The Biochemical oxygen demand of sewage is that the quantity of oxygen required for the biochemical oxidation of the decomposable matter at specified temperature within the specified time. During natural decomposition, the life activities of organism are stimulated by high temperatures and decreased at low temperatures. Therefore, the temperature and time during B.O.D. tests are testified. It are often seen that within 5 days period, about 60 to 70% biochemical oxidation is completed. Within 20 days period it is about 80 to 100 % completed. As biochemical oxidation is a slow process it take an infinite time for completion. Providing larger period for B.O.D determination is not convenient therefore 5 days period is adopted for B.O.D test. 20c temperature is employed as an average value for slow moving streams in temperate climate and can be easily duplicated in an incubator the rate or biochemical reaction increase with temperature and B.O.D values determined at different temperature will be different.The use of BOD test is (1) to determine the quantity of oxygen that will be required to stabilize the organic matter present, (2) to determine the size of treatment facility & (3) to measure the efficiency of plant.

Dissolved oxygen (DO) levels in environmental water depend on the physiochemical and biochemical activities in water body and it's a crucial useful in pollution and waste treatment process control. Two methods are commonly wont to determine DO concentration:
(1) The iodometric method which is a titration-based method and depends on oxidizing property of DO and
(2) The membrane electrode procedure, which works supported the rate of diffusion of molecular oxygen across a membrane.

The term "solids" is usually used when pertaining to any material suspended or dissolved in wastewater which will be physically isolated either through filtration or through evaporation. The analysis of this features a great importance because the planning of the filter is depends thereon. Solids may affect water or effluent quality adversely in a number of ways. Waters with high dissolved solids generally are of inferior palatability and should induce an unfavorable

physiological reaction in the transient consumer. For these reasons, a limit of 500 mg total solids/l is desirable for treated effluent of waste water. The total solids comprises of two sorts of solids that are suspended solids and dissolved solids.

Fig.4.2 : BOD Graph

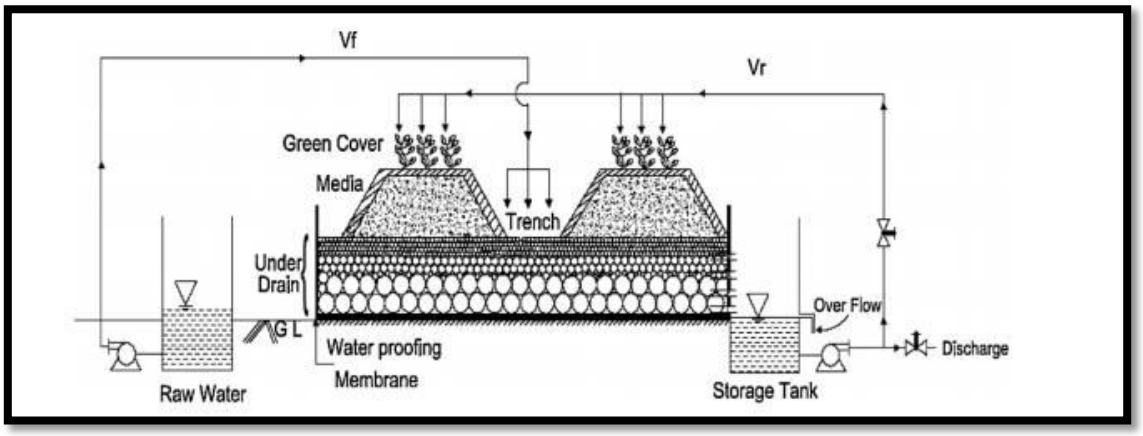

Fig.4.3 : . Upper and lower media showing layout for processing water

IV. RESULTS AND DISCUSSION

After analysis the test results are compared with the CPCB board. The results were observed are covered in following table.

Table 4.1: Test results

Sr. No.	Test Parameters	Unit	Raw Sewage Sample	Acceptable limits of Treated Water	Treated Water Sample
1	pH	-	6.7 to 7.8	6.5 to 7.5	7.4
2	Odor	-	Pungent	Agreeable	Agreeable

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| Volume 10, Issue 6, June 2023 |

3	Total Suspended Solids	mg/l	1200	< 10	BDL (DL-10)
4	Chemical Oxygen Demand	mg/l	400	< 50	30.40
5	Biochemical Oxygen Demand	mg/l	200	< 10	8.12
6	Dissolved Oxygen	mg/l	3.2	> 5	6.2
7	Nitrate (as NO3)	mg/l	35	< 45	28.45

After the analysis of test results the following discussion were made that are suitable treatment units to be made for the proper treatment. The units of designed treatment facility consists screening chamber, plain sedimentation tank, soil biotechnology filter (soil scape filter) with attached storage tanks.

CONCLUSION

Soil Biotechnology is one of the environments friendly technologies. SBT is having very high potential in minimal requirement of power; Power is needed only when pumping system is required to pump water in and out of the reactor. This requirement can be reduced further if the water is allowed to flow by gravity. Further, the plant does not require uninterrupted operation and is meant to be run for a few hours a day. Thus SBT is a strong technology where uninterrupted power supply is problematic or not possible. Also for operating SBT skilled manpower id not required.

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