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EXPERIMENTAL ASSESSMENT OF DEPTH OF CONTACT MEDIA AND RATE OF FLOW OF SEWAGE FOR SELECTED MATERIAL IN SOIL BIOTECHNOLOGY

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ABSTRACT

Soil Biotechnology (SBT) is one of the emerging decentralized wastewater treatment technologies for small communities with several advantages. The establishment of treatment process involves experimental evaluation of its components, with locally available material for required degree of treatment. In this connection, an attempt has been made to study the required depth of contact media for different rates of application of domestic sewage for a chosen local material for Soil biotechnology treatment process. For which a column experimental study was conducted for sewage flow rates of 0.50, 1.00, 1.50, 2.00, 2.50 l/hr using dosing pump, after clarification in settling tank. The fabricated column setup consists of 100 mm diameter pvc pipe filled with locally available over burnt brickbats as contact media, culture catalyst and appropriate Inlet and outlets. The investigation was carried out at designated depths of 1.50 m, 2.00 m, 2.50 m and 3.0 m. The percentage removal of Biochemical Oxygen Demand (BOD) & Chemical Oxygen Demand (COD) was observed at each depth for a selected rate of sewage flow. It is found that 81.2 – 94.2% of BOD and 78.4 - 90.7% of COD removal were observed at 3.0 m depth for all discharges considered in the present study. While 69.1 – 82.5% of BOD and 67.9 - 79% of COD were removed at 2.5 m depth for all discharges. The rate of removal of BOD and COD are increasing with increase in depth of contact media because of more contact time between sewage and contact media. Further, the rate of removal of BOD & COD is decreasing with increase in rate of application of sewage, since the rate of flow is inversely proportional to the contact time.

KEY WORDS : BOD, COD, Column study, Domestic sewage, Soil Biotechnology.

INTRODUCTION

Now a days decentralized wastewater management is increasingly being concerted for the treatment of domestic wastewater in small communities, such as apartments, educational institutions, organizations, where the sewage is treated in their premises and reused for flushing of water closets, local gardening, lawn maintenance without disposing it to outside environment. One such decentralized wastewater treatment system is Soil Biotechnology (SBT). A typical SBT is shown in Fig. 1.

SBT is a modified trickling filtration process, where the sewage is purified naturally by adsorption, mineral weathering, filtration and biological action. In addition, there are several advantages with SBT such as efficient removal of BOD and COD with minimum energy consumption,

Fig. 1. Typical Soil BiotechnologyTreatment plant

very low or no sludge production, free from odor, no requirement of skilled persons,etc. The treatment process need not be continuous, can be operated in batch mode.

SBT consists of one or two bioreactors / mounds. For better quality of effluent two bioreactors are provided in series. The principal components of a bioreactor are contact media and nozzles arrangement at the top of contact media for the application of sewage, along with settling and collection chambers. Gravel or brickbats are used as contact media in bioreactors with culture catalyst. The number of nozzles and depth of contact media required in SBT depend on the nature of sewage, degree of treatment required, type and depth of contact media, rate of application of sewage.

For the construction of a SBT, it is necessary to find out the depth of the selected contact media, rate of application of sewage, experimentally, for the required quality of effluent.

MATERIALS AND EXPERIMENTAL METHODOLOGY

Contact Media

Locally available over burnt clay brick bats from a brick industry are considered as contact media (Fig.2), which are of 20-30 mm size with uniform texture and rate of burnt. They are strong enough, having 15.20% of water absorption and 2.29 of specific gravity. Proper care is taken while selecting the brick aggregate, that they wouldn't become powder in the filter media, when they are in soaked state in sewage and when sewage flow exerts force on the brickbats.

Culture Catalyst

Culture catalyst is a chemical compound which contains macro/micro nutrients for bacteria which

Fig. 2. Over burnt clay brickbats used as contact media in the experimental setup

can grow over a wide temperature range. When added to soil bioreactor the catalyst immediately begins to secrete enzymes that digest and decompose feces, urine, grease, fats, food scraps and other organic wastes. The required microbes in the bioreactor rapidly multiply and colonize in the bioreactor, thereby restoring its biological health and efficiency.

Experimental Setup

A 3.5 m length of 10 cm diameter PVC pipe is used for the fabrication of experimental setup. The pipe is filled with stone aggregate up to 0.2 m by closing the bottom end of the pipe with a cap. The remaining length of pipe is filled with burnt clay brick aggregate and culture catalyst in layers as shown in Fig.3, leaving 0.3 m of free board at top. At every 1.0 m interval from the top of media, a layer of culture catalyst (300 g) is placed. Experimental setup – laboratory model is shown in Fig.4.

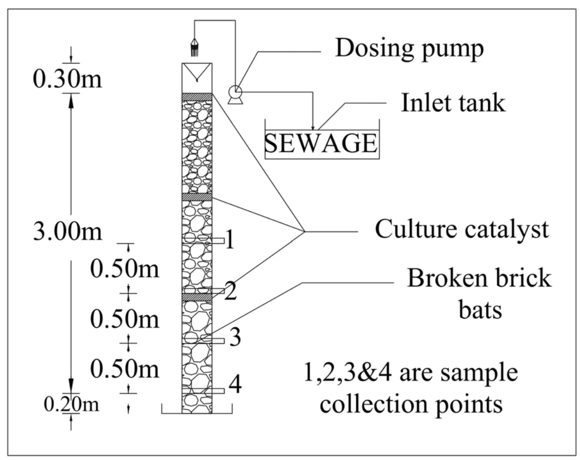

Fig. 3. Experimental setup

Holes are made to collect the samplesat 1.50, 2.00, 2.50, 3.00m from the top of the contact media in the pipe. A small flexible transparent PVC pipe of 1.7cm diameter and the 15 cm length was inserted through each hole up to the middle of the setup and the inner part of pipeis made into a half circle. These are placed and fixed with glue so that sewage samples at different depths can be collected through this arrangement.

Raw sewage is taken in a 50 l plastic drum which was used as an inlet tank. The suction pipe of dosing pump is connected to the inlet tank. The dosing pump pumps and regulates the flow to the Column reactor (Experimental setup). A nozzle is connected to the delivery pipe of dosing pumpto aerate the sewage andfunnel is inserted at top of the

Fig. 4. Experiment setup – laboratory Model

setup to direct the sprayed sewage to the contact media.

Experimental procedure

Initially, the domestic sewagewas run through the experimental setup for two weeks to allow the biological slime layer to grow on contact media.

Influentwas analyzed for its Biochemical oxygen demand (BOD) at 27 ^{0}C for three days and Chemical oxygen demand (COD) in the laboratory. Then the experiment was started by applying sewage at 0.50 l/hr. Effluents from outlets at 1.50, 2.00, 2.50 and 3.00 m depth, were collected after 8 hrs of the application of sewage. Three sampleswere collected at every depth and BOD & COD values were determined as per the standard methods. Average of three readings were considered for each reported value. Same procedure was followed for other sewage flow rates of 1.00, 1.50, 2.00 and 2.50 l/hr.

During treatment, the sewage is aerated at two phases, one is while spraying the sewage at inlet point and the other is while trickling through contact media. Thus the sewage is well aerated and organic matter is oxidized primarily by aerobic decomposition, in addition to adsorption and filtration in the experimental setup.

Analysis of samples

Raw sewage as well as treated effluents collected from the experimental setup were analyzed for COD and BOD at 27 ^{0}C for 3 days, immediately after their collection from the experimental setup.

RESULTS AND DISCUSSION

The BOD and COD values of raw sewage are found to be 117 mg/L and 198 mg/L. For0.50 l/hr flow rate, the BOD values of effluents at 1.50 m to 3.0 m depth of contact media are ranging between 45.16–6.79 mg/L, while COD values are ranging between 81.38 – 18.41 mg/L. The contact time between media (biomass) and organic matter present in sewage is maximum at 0.5 l/hr when compared to the other higher discharges considered in the present study. This could be the main reason for getting better quality of treated effluents, in terms of BOD and COD removal. The BOD and COD values of effluentsat every depth of contact media are presented in Fig. 5. The variation in efficiency in terms of BOD and COD removal at different depths for 0.50 l/hr rate of flow is found to be 61.4 to 94.2% of BOD and 58.9 to 90.7% of COD, as shown in Fig.10 (a) & (b). About 82% and 79% of BOD and COD removal were observed at 2.50 m depth of contact media.

For 1.00 l/hr, the effluent BOD & COD values are steadily decreasing from 49.14 to 9.94 mg/L, and from 85.34 to 23.36 mg/L respectively with increase of depth of contact media, as shown in Fig.6.BOD and COD removalat different depths for 1.00 l/hr rate of flow are found to be 58 to 91.5% and 56.3 to 88.2% respectively, as shown in Figs. 10 (a) and (b). About 79% and 76% of BOD and COD removal were observed at 2.50 m depth of contact media.

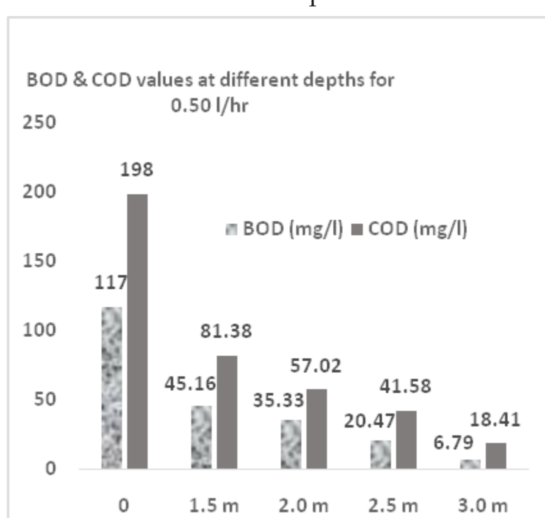

Fig. 5. BOD and COD values at different depths for discharge of 0.50 l/hr

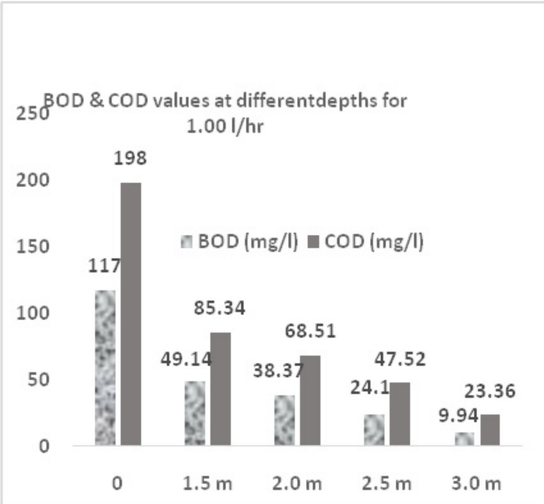

Fig. 6. BOD and COD values at different depths for discharge of 1.00l/hr

For 1.50 l/hr, the treated effluent BOD & COD values are ranging from 51.13 to 13.34 mg/L, and from 90.09 to 28.91 mg/l respectively with increase of depth of contact media, as shown in Fig.7. BOD and COD removalat different depths for 1.50 l/hr rate of flow are found to be 56.3 to 88.6% and 54.5 to 85.4% respectively, as shown in Figs. 10 (a) and (b). About 75% and 72% of BOD and COD removal were observed at 2.50 m depth of contact media.

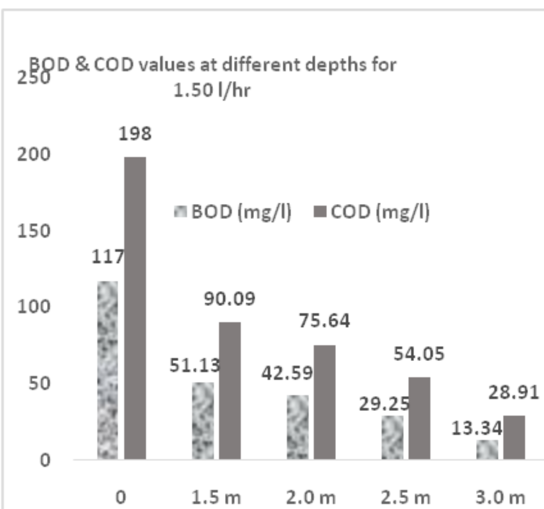

Fig. 7. BOD and COD values at different depths for discharge of 1.50 l/hr

For 2.00 l/hr rate of flow, the effluent BOD and COD values are gradually decreasing from 55.22 to 18.25 mg/l, and from 97.02 to 37.62 mg/l respectively with increase of depth of contact media, as shown in Fig.8. BOD and COD removalat different depths for 2.00 l/hr are found to be 52.8 to 84.4% and 51.0 to 81.0% respectively, as shown in Figs.10 (a) and (b). About 71% and 70% of BOD and COD removal were observed at 2.50 m depth of contact media.

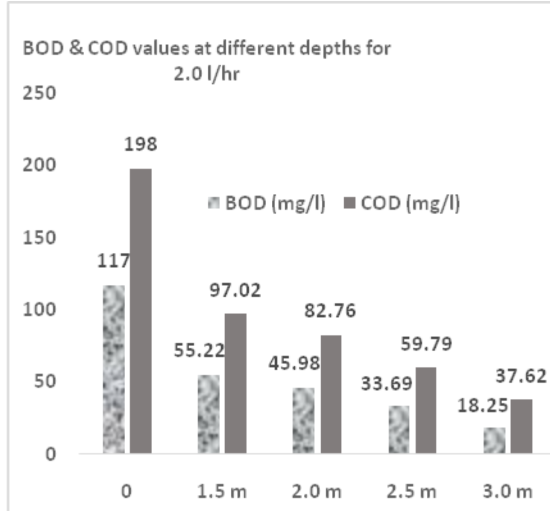

Fig. 8. BOD and COD values at different depths for discharge of 2.00 l/hr

For 2.50 l/hr, the effluent BOD values are ranging between 59.2 – 21.99 mg/l, while COD values are ranging between 101.57 – 42.77 mg/l at 1.50 m to 3.0m depth of contact media. The contact time between media (biomass) and organic matter present in sewage is minimum when compared to the other lower flow rates considered in the present study. This could be the main reason for getting relatively low quality of treated effluents. The treated effluent BOD and COD values at every

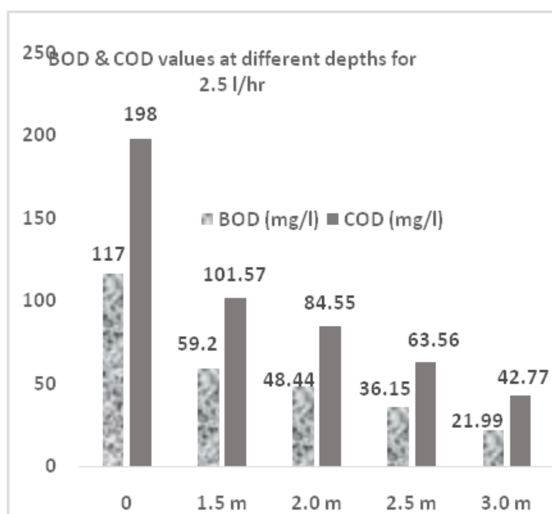

Fig. 9. BOD and COD values at different depths for discharge of 2.50 l/hr

depth of contact media are presented in Fig. 9. The variation in efficiency at different depths for 2.50 l/hr rate of flow is found to be 49.4 to 81.2% of BOD and 48.7 to 78.4% of COD, as shown in Figs. 10 (a) & (b). About 69% and 68% of BOD and COD removal were observed at 2.50 m depth of contact media.

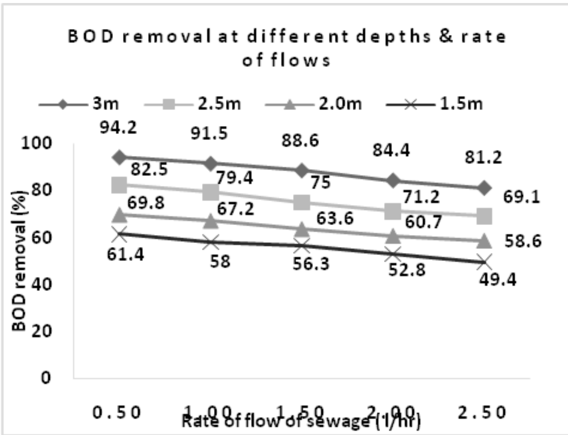

Fig. 10 (a). Percentage removal of BOD from domestic sewage of 117 mg/L

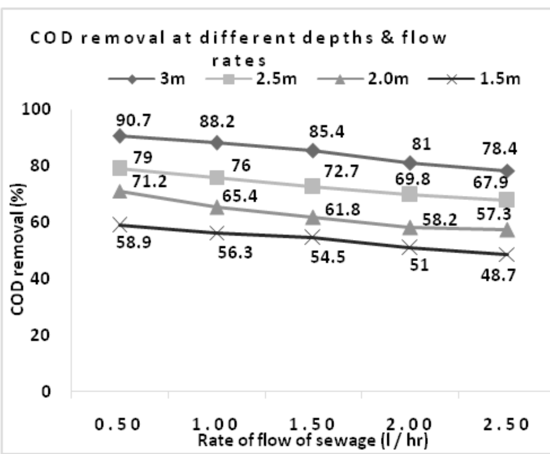

Fig. 10 (b). Percentage removal of COD from domestic sewage of 198 mg/L

Fig. 11. Sewage sample before treatment (right) and after treatment sample (left) at 3.0 m depth and 2.5 l/hr rate of flow

CONCLUSION

There is a clear cut evidence that the rate of removal of either BOD or COD increasing with increase in depth of contact media, for all rate of applications of sewage. This may be due to increase in contact time, between Sewage and contact media, with depth.

Further it is also observed the efficiency of Bio-reactor is decreasing with increase of rate of application of sewage, at all depths studied in the present study, since the rate of application inversely proportional to the contact time.

Fig. 11 shows the physical difference of quality of wastewater sample before treatment and after treatment.

By providing two bioreactors in series better removal can be obtained even at selected depth of contact media.

Other way, better results can be obtained by recirculating the treated effluent second time through same bioreactor.

REFERENCES

Kadam, A., Oza, G., Nemade, P., Dutta, S. and Shankar, H. 2008. Municipal wastewater treatment using novel constructed soil filter system. *Chemosphere.* 71(5) : 975-981.

Hardik Kananiand Bina Patel, 2017. Domestic wastewater treatment by Soil Biotechnology. *International Journal of Advance Research and Innovative Ideas in Education.* 3(2) : 4143-4147.

Implementation and performance evaluation of soil biotechnology plant for wastewater treatment, available at arghyam.org.

Manju Minhas and Shefali Bakshi, 2017. Case Study based comparison of popular wastewater treatment technologies in Present Scenario. *International Journal on Emerging Technologies.* 8(1) : 174-178.

Raju, M.V.S. 2019. Performance Assessment Of Soil Biotechnology Treatment Process-A Case Study. *Indian Journal of Environmental Protection.* 39 (11): 1069-1072.

SheetalJaisinghKamble, YogitaChakravarthy, Anju Singh, Caroline Chubilleau, Markus Starkl and Itee Bawa. 2017. A soil biotechnology system for wastewater treatment: technical, hygiene, environmental LCA and economic aspects. *Environmental Science and Pollution Research.* 24 (15) : 13315-13334.

Soil Biotechnology for Sewage Treatment, available at www.cleanindiajournal.com.

Soil biotechnology for sewage treatment, available at www. commonfloor. com.

IS-3025. Methods of sampling and test (physical and chemical) for water and wastewater.