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ROOT ZONE TECHNOLOGY FOR WASTE WATER TREATMENT

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Abstract:
In India, the primary cause of surface and ground water pollution is the discharge of untreated sewage, according to a 2007 study by the Central Pollution Control Board. In India, there is a significant delay between the generation and treatment of household wastewater. India's insufficient treatment capacity is not the only issue; there are also sewage treatment plants that exist, but they are not being maintained or operated. Because of poor design, inadequate maintenance, unreliable electricity supplies, absentee staff, and incompetent management, the majority of government-owned sewage treatment plants remain closed for the most part of the year. Usually, the wastewater produced in these places evaporates or percolates into the soil. Uncollected waste builds up in urban areas, releasing pollutants that seep into surface and groundwater and creating unsanitary conditions. Furthermore, industrialists prefer not to treat the waste produced and instead to dump it untreated into rivers in the areas where these treatment plants are located because the cost of treatment is so high.

The Root Zone Treatment System (RZTS), sometimes referred to as the reed bed system or the constructed wetland system, is a sealed filter bed that is planted with vegetation that can grow in wetlands and is made up of a sand, gravel, and soil system, sometimes with a cohesive element. The wastewater flows through the filter bed, where biodegradation of the wastewater occurs, after the coarse and floating material has been removed. Complex physical, chemical, and biological processes that are the outcome of the interaction of wastewater, wetland plants, filter bed material, and microorganisms define the functional mechanisms in the soil matrix that are in charge of the mineralization of biodegradable matter.

Keywords: Root Zone technology, reed bed system,filter bed,wate water**.**

I. INTRODUCTION

One of the most important issues the world is currently dealing with is environmental pollution. Urbanization, industrialization, and population growth are the main issues in India that contribute to environmental contamination. Our first priority should be to find a solution to this environmental problem.

In India, the primary cause of surface and ground water pollution is the discharge of untreated sewage, according to a 2007 study by the Central Pollution Control Board. In India, there is a significant delay between the generation and treatment of household wastewater. India's insufficient treatment capacity is not the only issue; there are also sewage treatment plants that exist, but they are not being maintained or operated. Because of poor design, inadequate maintenance, unreliable electricity supplies, absentee staff, and incompetent management, the majority of government-owned sewage treatment plants remain closed for the most part of the year. Usually, the wastewater produced in these places evaporates or percolates into the soil. Uncollected waste builds up in urban areas, releasing pollutants that seep into surface and groundwater and creating unsanitary conditions. Furthermore, industrialists prefer not to treat the waste produced and instead to dump it untreated into rivers in the areas where these treatment plants are located because of the exorbitant treatment costs.

According to a study conducted by the World Health Organization in 1992, only 209 of India's 3,119 towns and cities have full wastewater treatment facilities, and only 8 have partial treatment facilities. The untreated water is used downstream for washing, bathing, and drinking. A report further stated that 114 Indian cities were directly disposing of partially cremated bodies and untreated sewage into the Ganga River. The World Health Organization (2005) found that the main source of water pollution in India is sewage discharged from cities and towns. The difference between the 29000 MLD of sewage that India produces and its treatment capacity of only 6000 MLD must be filled with investment. A large number of Indian rivers are severely polluted as a result of discharge of domestic sewage.

Also, the water quality monitoring found almost all rivers with high levels of BOD. The worst pollution, in decreasing order, were found in river Markand (590 mg/l), followed by river Kali (364mg/l), river Amlakhadi (353mg/l), Yamuna canal (247mg/l), river Yamuna at Delhi (70) and river Betwa (58). For context, a water sample with a 5 day BOD between 1 and 2 mg/L indicates a very clean water, 3 to 8 mg/L indicates a moderately clean water, 8 to 20 indicates borderline water, and greater than 20 mg/L indicates ecologically unsafe polluted water.Report of The Committee for Drafting National Water Framework Law (2013), states that Water quality in all rivers, streams, surface water bodies, aquifers and other water sources throughout the country, shall be protected and improved. It also includes that the waste water generated from industrial area must be treated before dumping into the rivers or any other water bodies.

Processes including primary sedimentation, aeration, secondary treatment, and chlorination are used in traditional waste water treatment plants. The initial outlay for these treatment plants is substantial. Furthermore, the treatment plant needs more space and has high maintenance costs.These treatment facilities use a variety of chemicals for the aforementioned procedures, which raises operating expenses. Skilled labor is needed to keep the plant operating and maintained properly. Processes including primary sedimentation, aeration, secondary treatment, and chlorination are used in traditional waste water treatment plants. The initial outlay for these treatment plants is substantial. Furthermore, the treatment plant needs more space and has high maintenance costs.These treatment facilities use a variety of chemicals for the aforementioned procedures, which raises operating expenses. Skilled labor is needed to keep the plant operating and maintained properly.

II. LITERATURE REVIEW

Jan Vymazal et al. (2005) in this study, Horizontal sub-surface flow constructed wetlands (HFCWs) Ondrejov and Spalene Porici have been in operation since 1991 and 1992, respectively, and are the oldest systems in the Czech Republic. CW Ondrejov treats sewage from 362 PE in a single 806 m2 bed planted with Phragmites Australis. CW Spalene Porici treated wastewater from 700 PE from a combined sewerage until 2001 and then another part for additional 700 PE was completed in 2002. At present, there are six beds planted with a mixture of P. australis and Phalaris arundinacea with a total area of 5000 m2.Constructed wetland Ondrejov treatment performance has been very steady over the period of operation and exhibited ‘‘typical’’ efficiency for organics (average BOD5 inflow and outflow concentrations of 198 mg/l and 18 mg/l, respectively) and suspended solids (average inflow and outflow concentrations 204 mg/l and 9 mg/l, respectively).

Nischita V. K et al. (2012) in this study it is seen that the average BOD removal efficiency of designed unit (modified design of RZTS and trickling bed) is 85.25% up to 0.5m root zone bed depth, and is of average 79.45% for total 1.5m combined bed depth. The average COD removal efficiency of designed unit (modified design of RZTS and trickling bed) is 85.25%upto 0.5m root zone bed depth, and is of average 79.45% for total 1.5m combined bed depth. The average TSS removal efficiency of designed unit (modified design of RZTS and trickling bed) is 91.83% up to 0.5m root zone bed depth, and is of average 83.07% for total 1.5m combined bed depth.

Tamas M Garay et al. (2009) has studied the constructed wetland which is a near natural wastewater treatment technique, where reed (Phragmites Australis) is an important component. The high rate of small residential settlements (less than 2000 population equivalent (PE)) in Hungary suggests the consideration of cost-effective, locally operating wastewater treating methods. The present casework compares the conventional activated sludge treatment with the near-natural root- zone technology by means of the pollutant removal capacity of currently operating waste treatment plants. Examination of the water quality data shows that reed bed systems have a stable removal efficiency of organics of a similar rate to the conventional technologies, while in view of nutrients they have higher retention ability, so are beneficial against nitrification.

Brandon Kiracofe et al. (2004) in this study field tests were conducted and historical operating data were evaluated to assess the performance of the Monterey WWTP utilizing subsurface flow (SF) constructed wetlands. Previous work with SF wetlands has demonstrated adequate, but variable removal of organic matter, suspended solids, and nitrogen. Few research studies have observed the generation of compounds in the wetlands that affect other treatment processes, specifically reduced compounds that contribute to the chlorine demand. This study attempts not only to distinguish the factors leading to the inadequate performance of the SF wetlands in removing organic matter and nitrogen, but also to identify the cause of the frequent occurrences of a no detectable chlorine residual in the chlorine contact tank at the Monterey WWTP. Collection and analysis of historical operating data from January 1998 to May 2000 revealed a constantly decreasing removal of biochemical oxygen demand (BOD5) by the SF wetlands and a poor removal of ammonia-N throughout the system. The decreasing removal of BOD5 appeared to be caused by clogging of the wetland bed media by accumulated solids.

Trivedy R.K. et al. (2007) investigated that using constructed wetlands, wastewater can be treated at lower costs than other treatment options, with lowtechnology methods where no new or complex technological tools are needed. The system relies on renewable energy sources such as solar and kinetic energy and wetland plants and microorganisms, which are the active agents in the treatment process. There are inherent limitations to the effectiveness of rhizosphere treatment system for wastewater treatment. Nevertheless, rhizosphere treatment is often the best choice for treatment or pre-treatment of wastewater because of low maintenance cost and simplicity of operation and high efficiency and to add, they enhance the aesthetic value of the local and conserve the fauna and flora

III OBJECTIVES OF INVESTIGATION

- The main objective is to study the waste water treatment using Root zone technology, various methodologies in Root zone technology, efficiency of the RZT and the designing the RZT.

- The objective is also to facilitate the utilization of the Root zone technology for the treatment of waste water from various sources and also to study a cheaper alternative for waste water treatment using local available materials.

IV METHODOLOGY

a) Construction and working of reactor:

Studies were conducted to assess the feasibility of Root Zone Technology for sewage treatment. The study has conducted on pilot scale reactors on different types of plant species. There are two types of pilot scale reactors. First reactor is of size 128 cm x 58 cm x 40 cm and other three reactors have diameter 30 cm and height 35 cm. Plants are irrigated with sewage at regular interval of 5 days and growth of plants is observed. Different plants are irrigated with sewage with % of dosage starting from 25% of sewage and results are observed for 75% of sewage till date. There are 4 plant species on which observation is carried out. After steady state is reached, the quality of treated waste water will be assessed.

b) Inlet Arrangement:

Inlet arrangement is a trickling filter which consists of graded filter having aggregate size 40 mm and 10 mm. 40 mm size aggregate forms the lower layer of 10cm and 10 mm size aggregate form 25 cm layer above 40 mm size aggregate.

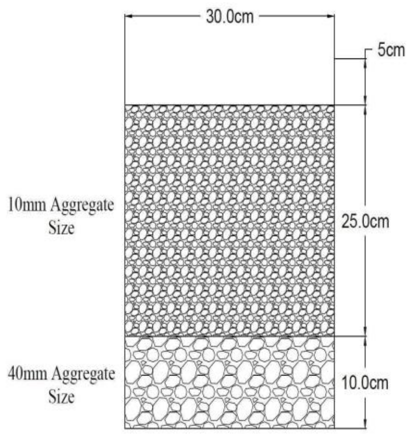


Fig. Various layers of trickling filter.

c) Pipe arrangement:

At the bottom of the trickling filter a pipe arrangement is provided for even distribution of sewage water in the reactor. A pipe carries the waste water from the bottom of the trickling filter and is connected to the valve arrangement to control the flow of sewage waste water that is applied to the reactor. A T-joint is provided at the end of the valve arrangement and two pipes are attached to this joint and these two pipes are provided with four holes each at equal spacing for even distribution of the sewage waste water.

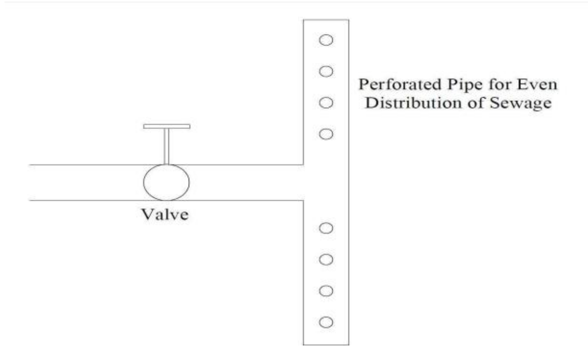


Fig.:Pipe Arrangement.

Outlet arrangement:

Outlet arrangement consists of perforated pipe which is used to collect the treated water and a valve is provided to control flow. Perforation was made only on the top portion of the pipe while the bottom portion was not perforated so that pipe can channelize the treated water to the outlet valve. A T joint was provided as shown in the Figure and the pipe was connected to the valve arrangement.

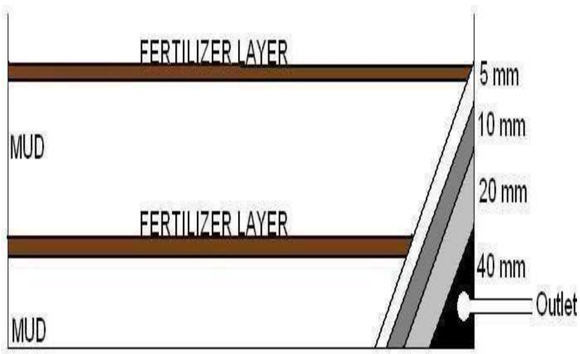


DIAGRAM OF REACTOR

Graded Filter:

A graded filter is provided over the pipe to stop entry of the mud into the treated water.Graded filter is made of aggregate size 40 mm, 20 mm, 10mm and 5mm and layers are inclined in nature. At first the 40 mm aggregate layer was provided and the layer was spread up to half of the length of the reactor and over this layer 20 mm aggregate layer was provided and void to large extent were filled. After laying this layer a mixture of 10 mm and 5 mm aggregate were laid on top of 20 mm layer filling all voids and these layers were compactedproperly.

Fig. First layer of 40 mm aggregate

Fig.Second layer of 20 mm aggregate.

Reactor Arrangement:

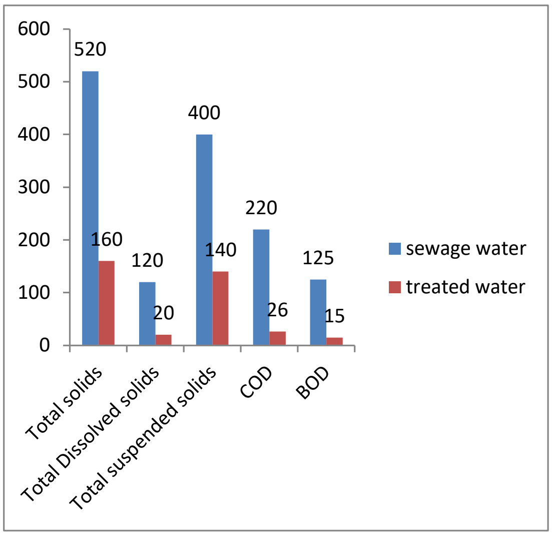
After graded filter is arranged in the reactor, a mud layer of 20 cm is laid in the reactor and then a thin layer of fertilizer is laid on this mud layer and again a layer of 20 cm is laid with a thin layer of fertilizer on the top.

Fig. Layer of mud.
Fig.Pilot model of the reactor with Phragmite Austrails.

V RESULTS

TableNo.1(for phragmite austrails): Results for sewage and for treated effluent

Sr No.	Test Parameter	For Sewage	For Treated Effulent	Standard Value
1	Total Solids	520 mg/l	160 mg/l	480 PPM
2	Total Dissolved Solids	120 mg/l	20 mg/l	100 PPM
3	Total Suspended Solids	400 mg/l	140 mg/l	100 PPM
4	COD	220 mg/l	26 mg/l	200 PPM
5	BOD	125 mg/l	15 mg/l	100 PPM



Graph no 1. Results for sewage and for treated effluent

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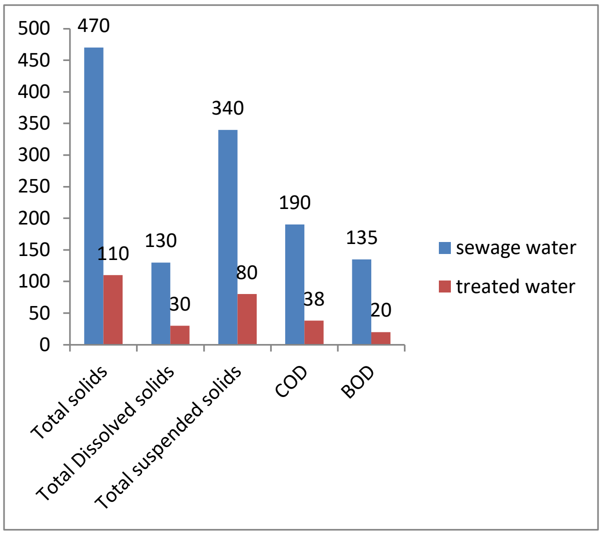
Table No.6 (For Canna Indica):Results for sewage and for treated effluent

Sr No.	Test Parameter	For Sewage	For Treated Effulent
1	Total Solids	470 mg/l	110 mg/l
2	Total Dissolved Solids	130 mg/l	30 mg/l
3	Total Suspended Solids	340 mg/l	80 mg/l
4	COD	190 mg/l	38 mg/l
5	BOD	135 mg/l	20 mg/l



Graph no 2. Results for sewage and for treated effluent

VI CONCLUSIONS

- This study demonstrated that the designed sub-surface horizontal flow constructed wetland system could be used for treatment of the campus waste water. A constructed wetland system can be an effective treatment facility for campus waste water.
- Regarding the performance achieved, the sub-surface horizontal flow constructed wetland was able to reduce further the level of the main physicochemical pollution parameters. The plants do play an important role in the treatment.
- The treatment level was affected by not only by the change of seasons, but also by the variation in influent quality and quantity.

• The overall experimental results demonstrated the feasibility of applying subsurface horizontal flow constructed wetland unit to treat campus waste waters. Thus the root zone treatment can be utilized independently or as an addition to conventional treatment for complete treatment of waste water.

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