Novateur Publications
International Journal of Innovations in Engineering Research and Technology [IJIERT]
ISSN: 2394-3696 Website: ijiert.org
Volume 11, Issue 03, March-2024

OVERVIEW OF ROOT ZONE TECHNOLOGY

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Article History: *Received on: 30/12/2023*
Accepted on: 18/02/2024

DOI: *https://doi.org/10.26662/ijiert.v11i3.pp7-12*

Abstract

Central Pollution Control Board (2007) study found that discharge of untreated sewage is sthe single most important cause for surface and ground water pollution n India. There is a large gap between the generation and treatment of domestic wastewater in India. The problem is not only that India lacks sufficient treatment capacity but also that the existing sewage treatment plants are not operated and are not maintained. Most of the government-owned sewage treatment plants remain closed due to improper design, poor maintenance, or lack of reliable electricity supply to operate the plants, absentee employees, and poor management. The wastewater generated in these areas normally percolates in the soil or evaporates. The uncollected wastes accumulate in the urban areas cause unhygienic conditions and release pollutants that leach to surface and groundwater. Moreover, where these treatment plants exist, the cost of treatment is so high that industrialists favour not treating the waste generated and directly dumping the untreated waste into the rivers.

The Root Zone Treatment system (RZTS) also known as the reed bed system or constructed wetland system is a sealed filter bed consisting of a sand/gravel/ soil system, occasionally with a cohesive element, planted with vegetation that can grow in wetlands. After removing coarse and floating material, the wastewater passes through the filter bed where biodegradation of the wastewater occurs. The functional mechanisms in the soil matrix responsible for the mineralization of biodegradable matter are characterized by complex physical, chemical and biological processes resulting from the combined effects of the filter bed material, wetland plants, micro-organisms and wastewater. The root zone treatment system also known as the reed bed or constructed wetland system is a sealed filter bed consisting of a sand /gravel/soil system.

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

INTRODUCTION

Environmental pollution is one of the severe problems that the world is facing in this era. In India, significant problems leading to environmental pollution are increasing population, industrialization, and urbanization. Solving this environmental issue should be our top priority.

Central Pollution Control Board (2007) study found that discharge of untreated sewage is India's most important cause of surface and groundwater pollution. There is a large gap between the generation and treatment of domestic wastewater in India. The problem is not only that India lacks sufficient treatment capacity but also that the existing sewage treatment plants are not operated and are not maintained. The majority of the government-owned sewage treatment plants remain closed most of the time due to improper design, poor maintenance, or lack of reliable electricity supply to operate the plants, together with absentee employees and poor management. The wastewater generated in these areas normally percolates in the soil or evaporates. The uncollected wastes accumulate in urban areas, causing unhygienic conditions and releasing pollutants that leach to the surface and groundwater. Moreover, where these treatment plants exist, the cost of treatment is so high that industrialists favour not treating the waste generated and directly dumping the untreated waste into the rivers.

World Health Organization (1992) study is claimed to have reported that out of India's 3,119 towns and cities, just 209 have partial sewage treatment facilities, and only 8 have full wastewater treatment facilities. Downstream, the untreated water is used for drinking, bathing, and washing. Also, the report claimed that 114 Indian cities were dumping untreated sewage and partially cremated bodies directly into the Ganga River. According to the World Health Organization (2005) report, sewage discharged from cities and towns is India's predominant cause of water pollution. Investment is needed to bridge the gap between 29000 MLD of sewage India generates and a treatment capacity of a mere 6000 MLD. A large number of Indian rivers are severely polluted as a result of the discharge of domestic sewage.

Also, the water quality monitoring found almost all rivers to have high levels of BOD. The worst pollution, in decreasing order, was 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 very clean water, 3 to 8 mg/L indicates 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 wastewater generated from the industrial areas must be treated before dumping into the rivers or any other water bodies.

Traditional wastewater treatment plants include processes like primary sedimentation, aeration, secondary treatment, and chlorination. This form of treatment plant requires a high initial investment. Moreover, their maintenance cost is high, and the treatment plant requires more area. Such treatment plants consume different chemicals for the above-stated processes and increase the functioning cost. For the functioning and proper maintenance of the plant, skilled manpower is required. The results after the treatment of the wastewater are also not satisfactory. Overall, the treatment plants are costly, and the results are not up to the mark. Treatment of wastewater by traditional methods is very costly and neglected by most people. Such high investment can only be done by the government sectors. However, due to improper design and maintenance of the treatment plant, most of the plants are not functioning correctly, leading to direct disposal of the wastewater into nearby gutters and ultimately into the rivers, affecting the ecosystem.

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. They 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; another part for an additional 700 PE was completed in 2002. Six beds were 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 nine mg/l, respectively).

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

Tamas M Garay et al. (2009) studied the constructed wetland, 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 treatment methods. The present casework compares the conventional activated sludge treatment with the near-natural root-zone technology using 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 at a similar rate to the conventional technologies. In contrast, given nutrients, they have higher retention ability, so they are beneficial against nitrification.

Brandon Kiracofe et al. (2004) conducted field tests in this study and evaluated historical operating data to assess the Monterey WWTP's performance utilising 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.

Trivedi R.K. et al. (2007) investigated that using constructed wetlands, wastewater can be treated at lower costs than other treatment options, with low technology methods where no new or complex technological tools are needed. The system relies on renewable 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 simplicity of operation and high efficiency to add, they enhance the aesthetic value of the local and conserve the fauna and flora.

OBJECTIVES OF INVESTIGATION

- The main objective is to study the wastewater treatment using Root zone technology, various methodologies in Root zone technology, the efficiency of the RZT and the designing of the RZT.
- The objective is also to facilitate the utilisation of the Root zone technology for the treatment of wastewater from various sources and to study a cheaper alternative for wastewater treatment using locally available materials.

METHODOLOGY

a) Construction and working of reactor:

Studies were conducted to assess the feasibility of Root Zone Technology for sewage treatment. The study was conducted on pilot-scale reactors on different types of plant species. There are two types of pilot-scale reactors. The first reactor is of size 128 cm x 58 cm x 40 cm, and the other three reactors have a diameter of 30 cm and a height of 35 cm. Plants are irrigated with sewage at regular intervals 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 to date. There are four plant species on which observation is carried out. After a steady state is reached, the quality of treated wastewater will be assessed.

b) Inlet Arrangement:

Inlet arrangement is a trickling filter consisting of graded filters with an aggregate size of 40 mm and 10 mm. 40 mm size aggregate forms the lower layer of 10cm and 10 mm size aggregate of 25 cm layer above 40 mm size aggregate.

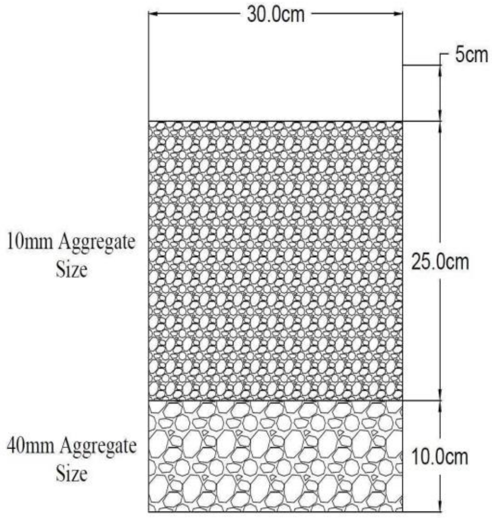

Fig.1: Various layers of trickling filter

c) Pipe arrangement:

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

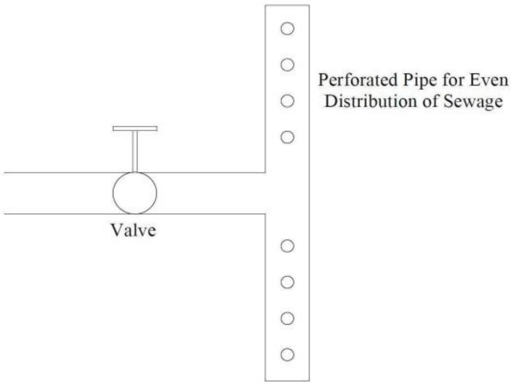

Fig.2: Pipe Arrangement

d) Outlet arrangement:

The outlet arrangement consists of a perforated pipe used to collect the treated water and a valve provided to control flow. Perforation was made only on the top portion of the pipe, while the bottom portion was not perforated so that the pipe could channel the treated water to the outlet valve. As shown in the Figure, a T joint was provided, and the pipe was connected to the valve arrangement.

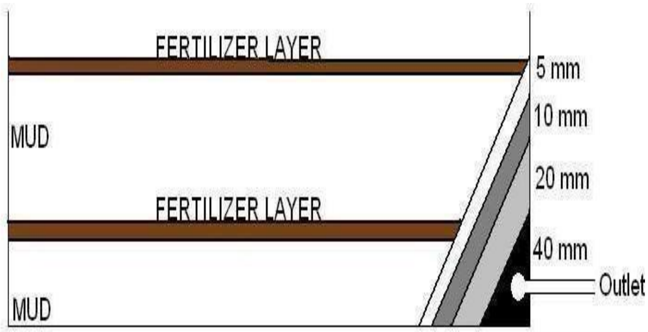

Fig.3: Diagram of the Reactor

EXPECTED CONCLUSIONS

➢This study demonstrated that the designed sub-surface horizontal flow constructed wetland system could be used to treat the campus wastewater. A constructed wetland system can be an adequate treatment facility for campus wastewater.

➢Regarding the performance achieved, the sub-surface horizontal flow constructed wetland could further reduce the level of the main physicochemical pollution parameters. The plants do play an essential role in the treatment.

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