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Treatment of Domestic Effluent by Horizontal Flow Planted Filter

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ABSTRACT

The facilities to treat wastewater are not adequate in any metro city or towns in India. Presently, only about 33% of the wastewater generated is treated and rest is discharged as it is into our water bodies (NIES). Therefore, in the present scenario, there exits needs of such a system that can be helpful in controlling water pollution at low cost and without involvement of skill persons. Several times chemical treatment approaches have been taken for sewage treatment in plants and for clearing collection lines but they all have disadvantages. The solution for these problems can be approached by adopting advanced biotechnology that is root zone treatment system. The process involves the bacterial action in the root zone by providing aerobic and anaerobic environment at different levels which finally results in conversion of complex organic compounds into simpler and products. Most popular plant constructed in India by using this technology is Horizontal Flow Planted Filter (HFPF). To understand performance of the filter the parameters, such as BOD, COD, TSS, pH and oil and grease of the treated effluent were analyzed at out lets. It has been observed in different samples that there is a reduction of about 88% in BOD, 92% in TSS, 80% in oil and grease content 70% in COD of the sample. This paper aims at treating the pre settled domestic effluent to tertiary standards by neutral biological methods.

Keywords : Root zone treatment, Effluent, BOD, COD, Detention time.

Introduction

Due to increase in population and habits of residents, most of the sewage treatment plants get challenged with hydraulic and organic shock loads. The pollutants in wastewater not only arise from domestic area and food service functions like restaurant, but also from some industries and small-scale industrial units. The soil root zone is termed as the area of the soil around the plant that comes in contact with the plant root. Constructed wetlands, reed bed filters, subsurface wetlands (all different terminologies used for artificial wetlands) have used for water treatment in various applications worldwide. They have been used for applications as diverse as sewage treatment, oil contaminated water treatment, heavy metal and phosphorus reduction in all types of wastewater and for industrial sludge wastes. Root zone process allow the treatment of municipal and domestic wastes to tertiary treatment standards and significantly reduce the area requirement and hence cost of new facilities for wastewater treatment as compared with the previous generation of constructed wetlands. The process is essentially a non user of energy relying on natural photosynthesis and biological degradation to achieve its objectives

The intelligent use of naturally occurring processes in a controlled sustainable and environmentally friendly manner to reduce energy consumption encourage to develop Horizontal Flow Planted Filter (HFPF) to clean up water pollution, air and land pollution and to conserve natural resources (CPCB, 2001)

Root zone filter mechanism

The 'root zone treatment' is a natural, maintenance free system where the wastewater is purified by the roots of the certain wetland plants like Cana Typha etc. The root zone process functions to effectively purify domestic and industrial effluents. Process was developed in the 1990's by professor Dr. Reinhold kickuth of Kassel University, Germany. The process incorporates the self-regulating dynamics of an ecosystem. The term 'root zone' encompasses the life interactions of various species of bacteria reside in the root of reed plants, soil, air ,sun and water. Because the reed plants (phragmites communis) get oxygen through there stems into there root system. The optimal conditions of the growth of bacteria are created which oxidized impurities in the wastewater. Since the process occurs underground so aerobic and anaerobic zones exists side by side and causes different types of chemical reaction balancing bacterial growth. More than 5000 types of bacteria are present in the root zone filter as compared to only 300 types in conventional biological treatment systems.

The process functions self regulating, purifying and simplifying process found in nature. Root zone installations are isolated from a surrounding ground water by an impregnable barrier of bentonite clay or masonry etc. This ensures that the impurities are confined and not allowed to enter the surrounding environment. The soil is carefully selected to provide optimal condition to both plant and bacterial growth. The water level in the fields is also controlled to get maximum root growth. Three integrated components to this system are given below.

Reeds : These reeds of the species, phragmites are essentially wetland plants, which have a capacity to intake oxygen from ambient air through there stomatal openings, behind there leaves. The oxygen is pushed through the porous stems of the reeds to the hollow roots, where it enters the root zone and creates optimal condition for the growth and survival of numerous bacteria and fungi. The quanta of reeds are selected as per the flow rate of wastewater.

Reed bed: A reed bed is a live, self cleaning, biological filter. It removes disease causing organisms, nutrients, organic load and a range of chemicals and other polluting compounds. The treatment of wastewater is achieved by the controlled seepage of the water born pollutants through the root zone of plants. The soil is carefully selected to provide optimal growth for plant and bacteria. The performance of the system is now dependent on the full growth of the roots across the depth of the constructed reed bed. Reed bed treatment system comprise self contained engineered ecosystemthat utilize particular combinations of plants, soil, bacteria and hydraulic flow to optimize the physical, chemical and microbiological processes with the root zone (Whyman and Goodman, 1993). There are two types of reed bed filter, vertical and Horizontal. Horizontal Flow Planted Filters are used in low solid situation and vertical filters

for high solids (sludge) situation. In some application a combination may be used to design the system as per specific wastewater or sludge characteristic and the required level of treatment. Consequently each project is custom designed according to effluent quality requirement, flow rates and location.

Microbial organism : The biodiversity is the key to the root zone process by which organic pollutants are broken down as a food source for the variety of microorganisms that dwell in the soil and plants. Other contaminants, such as heavy metals are fixed in by humic acid and cation exchange bonds in the soil or mineral substrates in which plants are rooted. The complexity of microbial life and the powerful organic chain reaction in the root zone of the plants result in an extraordinary cleansing capacity that adapts to change in a dynamic way. More than 5000 types of bacteria and tens of thousands of fungi like micro organisms are exist in the reed bed. These microbial organisms oxidise impurities of the wastewater. Since the process occurs underground, anaerobic and aerobic zones exist side by side including different types of chemical reactions and that balance bacterial growth, thus decomposing the contaminants to the basic simple compounds (Whyman and Goodman, 1993). Phosphates, nitrogenous materials, sulpher compounds etcreduced to there elemental forms, while BOD and COD are drastically brought down. Whereas heavy metal precipitated from solution and get bounded into the soil matrix. The outcome of this constructed marsh HFPF is treated effluent which not only environmentally acceptable but much cleaner.

Advantage and Applications

HFPF systems produce no noise or smells and produce no sludge or other byproducts with associated additional costs of disposal. This system achieves standards for tertiary treatment with low operating costs (low electricity, no chemicals for pH adjustment or for flocculation). It has low maintenance costs since it involves no machinery and its associated maintenance. It requires negligible attendance for operation and monitoring. It has no sludge handling problem as the sludge gets mineralized.

The wide range applications of root zone filters are oil exploration, petroleum, lubricant manufacturing and oil distribution, steel making, plastics production, chemical manufacturing, car and train, dairy production, fish processing, abattoirs, piggeries, resorts and caravan parks, mine water drainage, heavy metals removal, printing and paper industry, storm water treatment and poultry processing.

Material and Method

The effluent samples were collected from DEWAT (Decentralize wastewater treatment) unit HFPF established at Raghubeer Mandir, Jankikund Chitrakoot Satna Pradesh. Samples were collected and stored in plastic bottles for a period no longer then 1day.Care was taken to avoid entry of extraneous material, such as scum and floating matter into sampling bottles. DEWAT unit is consisting Screens, Anaerobic baffled reactor (ABR) followed by HFPF (Horizontal flow planted filter).There are few residential clusters in Raghubeer mandir in which about 100

persons reside as fixed population. However, number of residents may be higher in festival time. There are four bed of size 3.0 metre X 5.0 metre with 0.5 metre size inlet and outlet length. The depth of filter bed kept 0.60 metre in which 6 to 12mm size gravel filled and a top layer of 100 mm fertile soil is placed to cultivate the Reeds. Firstly influent is analysed for COD, BOD, pH and total solids. Then, by adjusting inflow from ABR the detention period of HFPF substrate is adjusted to 24 hours in first phase and remaining discharge is bypassed. The different parameters like COD, BOD, pH and total solids are analysed as mentioned in table 1. After this, the influent to HFPF adjusted to keep the substrate 48 hours in filter and different parameters are analysed following standard methods (Mahajan, 1985; Metcalf and Eddy, 2003). These parameters are mentioned in table 1.

Table 1

Parameter	Detention period 24 hours		Detention period 48 hours	
	Influent Characteristics	Effluent Characteristics	Influent Characteristics	Effluent Characteristic
COD in mg/l	480	270	492	132
BOD in mg/l	85	29	79	9
Oil and grease in mg/l	47	9	50	9
pH	5.9	6.1	5.9	6.7
Total solids in mg/l	1089	345	1138	76

Result and Discussion

In this paper, mainly emphasis is laid on the treatment of domestic wastewater on household. The HFPF pilot plant was set up in Raghubeer Mandir by growing plants naturally in a specified area and treating the wastewater on a small scale. The number of experiment was conducted before and after the treatment of domestic wastewater of different detention periods. Firstly, the domestic wastewater sample was analyzed for 24 hours detention period and then for 48 hours and different physical and chemical characteristics were obtained as mentioned in Table 1.It is clear for 24 hour detention time there is a decrease in the COD (from 480 to 270 mg/L) and BOD (from 85 to 29 mg/L), the decrease in the total suspended solids in the domestic wastewater in quiet significant that is from 1138 to 76 mg/L, another test was made on the measurement of the oil and grease content of the wastewater and it is found that is also approaches 50 to 9 mg/l, the pH of the wastewater also approaches5.9 to 6.1.

Secondly, the domestic wastewater sample was analyzed for 48 hours detention period, it is clear there is a decrease in the COD (from 492 to 132 mg/L) and BOD (from 79 to 9 mg/L), the decrease in the total suspended solids in the domestic wastewater in quiet significant that is from 1089 to 345 mg/L, another test was made on the measurement of the oil and grease content of the wastewater and it is found that is also approaches 47 to 9 mg/l, the pH of the wastewater also approaches 5.9 to 6.7. Thus the outgoing effluent meets the specified

standards and it can be safely used for agricultural purpose or can be safely discharged into the water bodies. So, these results show that the effluents can be treated at low operating costs without the use of harmful chemicals.

Conclusion

Being an engineer of developing nation, one has to give concern to Energy, Ecology and Environment while performing any task. This root zone horizontal filter treatment plant keeps in concern to all of these three factors. Now, if comparison is being made between this root zone technology and other conventional STP, then it can be ensured that it is more efficient in terms of controlling the environmental parameters of waste water (NIES). During the experiment conducted it has been concluded that there is a great reduction in the pollutants level, such as BOD and COD, total dissolved solid, oil and grease, ph level of the outgoing effluent. As far as energy consideration the energy requirement of the plant is very low since it doesn't need any electrical, chemical or mechanical energy. For economical consideration, the plant can be implemented at a very low cost especially as household plant. It does require very few maintenance and labour cost for operating and monitoring. This process is totally environmental friendly causing no harm to environment since no chemicals are used. It cause no odour and noise problem since it is in the vicinity of the roots. It has no sludge handling problem as the sludge gets mineralized by bacteria. However, it needed large area of land and frequent alteration of filter material. Inspite of this root zone technology may be considered as a sustainable answer to the treatment of domestic wastewater.

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