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Wastewater Treatment using Horizontal Subsurface Flow Constructed Wetland

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ABSTRACT

Conventional wastewater treatment systems comprising of energy intensive and mechanized treatment components require heavy investment and entail high operating costs. Constructed wetlands are accepted as a reliable wastewater treatment technology and represent an appropriate solution for the treatment of many wastewater types.

A constructed wetland is a shallow basin filled with some sort of substrate, usually soil or gravel, and planted with vegetation tolerant of saturated conditions

The role of constructed wetlands as environmental barrier and as a psychological separation is especially important for indirect potable reuse, when combined with other appropriate barriers. In addition to wastewater treatment, wetlands provide additional benefits, including environmental enhancement, habitat for plants and animals and passive recreational opportunities for the community. The studied constructed wetland reduced concentrations of contaminants present in the wastewater.

In this project, constructed wetland using horizontal subsurface flow is studied. Wastewater is treated in constructed wetland planted with aquatic plant Typhalatifolia. Initially wastewater is supplied to the wetland through inlet chamber. Treatment performance of a constructed wetland (CW) commissioned in a developing country was evaluated for removal efficiency of chemical oxygen demand (COD).

1. INTRODUCTION

Efficient wastewater treatment is critical for the world. There is unprecedented environmental pressure being exerted on the environment by the rapidly expanding population. This growing population requires adequate clean groundwater to drink. The environment demands relatively unpolluted surface water in streams and lakes to maintain the flora and fauna that humans have come to rely upon for food and recreation. Moeller estimates that 80% of the total disease burden in developing countries comes from waterborne illness. .Diarrhea still claims an estimated 2,000,000 children a year. ("Moeller, 2005). China reports that 300,000,000 of its citizens lack safe drinking water (Kurtenbach, 2005). In the USA, 95% of the population in rural areas receives its. Drinking water from groundwater-recharged wells (US Environmental Protection Agency, 1998). Water purification is the ultimate technique to ensure safe drinking water.

Wastewater contains a number of pollutants and contaminants, including plant nutrients (nitrogen, phosphorus, and potassium), pathogenic microorganisms (viruses, bacteria, protozoa), heavy metals (e.g. cadmium, chromium, copper, mercury, nickel, lead and zinc), organic pollutants (e.g. polychlorinated biphenyls, polyaromatic hydrocarbons, pesticides); and biodegradable organics (BOD, COD) and micro-pollutants (e.g. medicines, cosmetics, cleaning agents). All of these can cause health and environmental problems and can have economic/financial impacts (e.g. increased treatment costs to make water usable for certain purposes) when improperly or untreated wastewater is released into the environment; nutrient contamination and microbial water quality issues are considered.

2. METHODOLOGY

SUB-SURFACE FLOW WETLANDS A subsurface flow (SSF) wetland consists of a sealed basin with a porous substrate of rock or gravel. The water level is designed to remain below the top of the substrate. In most of the systems in the United States, the flow path is horizontal, although some European systems use vertical flow paths. SSF systems are called by several names, including vegetated submerged bed, root zone method, microbial rock reed filter, and plant-rock filter systems. Because of the hydraulic constraints imposed by the substrate, SSF wetlands are best suited to wastewaters with relatively low solids concentrations and under relatively uniform flow conditions. Despite a large amount of research and pub-lished information, the optimal design of con-structed wetlands for various applications has not yet been determined. Many constructed wetland systems have not been adequately monitored or have not been operating long enough to provide sufficient data for analysis. Among the systems that have been monitored, performance has varied and the influences of the diverse factors that affect performance, such as location, type of wastewater or runoff, wetland design, climate, weather, disturbance, and daily or seasonal variability, 'have been difficult to quantify.

Wetland substrates support the wetland vegetation, provide sites for biochemical and chemical transformations, and provide sites for storage of removed pollutants. Substrates include soil, sand, gravel, and organic materials. **SOIL** Many soils are suitable for constructed wet-lands.

Typha latifolia is common in constructed wetlands plant because of their widespread abundance, ability to grow at different water depths, ease of transport and transplantation, and broad tolerance of water composition.Plants are usually indigenous in that location for ecological reasons and optimum workings

3. Experimental setup:

A tub of twenty litres was taken for the experimental setup of model. Black cotton soil which is compatible for good growth of plants was taken in order to confirm good growth of plants.10 kg of soil was mixed with aggregate and sand to make the filtering of waste water more effectively and help wastewater purify. Plant naming typhalatifolia was brought from lake side which is the main filtering agent in the model.The model was placed at a position where it would get proper sunshine.The tub was filled with sand aggregates and soil having proportion of 1:2:8 which is compatible for proper filtering. The typhalatifolia plant was planted in the setup and proper watering was done to achieve the desired result. Municipal wastewater was brought from the Nag river in Nagpur from location of sitabuldi. The wastewater was filled from the inlet of the experimental setup shown above in fig. The wastewater was passed at a velocity of 10 ml/sec for proper filtering process taking place. Sample passed through the aggregate and sand through the roots of the plants which play a vital role in purifying the waste water. the main treatment happens when the water goes through the roots of the plant. After this the wasterwater is passed through a small portion of aggregate and sand to reach to the outlet, the water obtained in the outlet is odourless and non turbid.

4. Result add Discussion

Chemical oxygen Demand indicates the pollution strength of wastewater. Five tests on COD were done simultaneously the results obtained in the COD test were in the decreasing order as required the first reading obtained in the cod was 621.3mg/l whereas there was a decrease in the second reading by 11% and was recorded as 560mg/l

The third reading in the chemical oxygen demand was decreased by 18% and was obtained as 512mg/l the fourth reading was obtained as 455.2mg/l having decreased 27% as compared to first chemical oxygen demand test reading the fifth and final Reading was 410mg/l having decreased to 34%.In aerobic decomposition, aerobic heterotrophic microbes convert soluble organic matter to carbon dioxide and water. Reduction in COD of wastewater indicates that organic matter liable to biological degradation was removed by the Constructed Wetland system.

pH

The pH value of waste water is one of the important influencing parameter in treatment of waste water. pH value of waste water is a significant factor to maintain maximum rate of nitrification. five tests were done of ph.the std ph for good water is 7 and the results obtained were around 7 the result of the first reading was obtained to be7.3 in second reading it was 7.5 whereas in third it was 7.9 in fourth the reading was 8.2 and the final reading of ph was obtained as the 8.4. The pH value increased slightly from 7.3 to 8.4 reported that vegetated free-water surface wetlands produce effluent with pH just above neutrality.

5. CONCLUSION

There are many design factors which effect the effluent quality from a free water surface (FWS) constructed wetland. Consideration of some of these factors can significantly reduce the effluent variation. The monitoring of horizontal flow constructed wetland shows that the general performance of the system was good and it successfully reduced contaminants. The results indicate that if constructed wetlands are appropriately designed and operated, they could be used for wastewater treatment under local conditions, successfully. Contaminants are removed from wastewater through several mechanisms. Processes of sedimentation, microbial degradation, precipitation and plant uptake remove most contaminants. COD reduction observed was up to 34%, which indicates that Constructed Wetlands can effectively reduce pollution in wastewater. pH was increased from 7.3 to 8.4 which was responsible for increase in alkalinity. Dissolved oxygen was not much affected by constructed wetland treatment. Total dissolved solid reduction obtained was 45%. It shows that dissolved impurities can be eliminated by the processes of sedimentation, filtration and plant uptakes using constructed wetland. Hence constructed wetlands can be used in the treatment train to upgrade the existing malfunctioning wastewater treatment plants, especially in developing countries. With careful design and planning, a constructed wetland can efficiently remove a variety of contaminants. The treated wastewater from these wetlands can be used for landscape irrigation and also for other beneficial uses. Improvement can also be possible by increase in retention time of the wastewater in each compartment of the constructed wetland.

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