A STUDY ON INTEGRATED WASTE WATER TREATMENT IN WETLAND CONSTRUCTION USING *TYPHA LATIOFOLIA* AT DMICE

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Abstract - Water has increasingly become a scarce essential commodity and should be used judiciously. TAMIL NADU is having a severe drought and the whole country is having problems in meeting the demands of clean accessible water. Therefore, the only pragmatic approach to combat this situation of drought is water treatment. It is the most important method to solve the water crisis on planet earth. Wastewater treatment involves the reuse of waste water from factories, households and waters from polluted rivers or lakes. A constructed wetland is an artificial wetland that are engineered systems that use natural functions vegetation, soil, and organisms to treat wastewater and act as a biofilter to remove a range of pollutants (such as organic matter, nutrients, pathogens, heavy metals) from the water .This root zone waste water treatment system makes use of biological and physical-treatment processes to remove pollutants from wastewater Constructed wetlands is a natural alternative to the commonly used technical methods of wastewater treatment .A horizontal surface flow constructed wetland (HSF) has been designed to study the removal of nutrients and trace elements by treating urban sewage and passing through selected aquatic plants / aquatic macrophytes i.e., *Typha latifolia,.* Samples collected from inlet and outlet of the constructed wetland were analyzed for trace elements and physio-chemical characteristics This study is conducted to prove that Constructed wetlands are suitable eco-technology for remediation of urban wastes containing trace elements and high nutrients, before entering Rivers and other water bodies as well as for reusing.

***Key Words*: Constructed Wetland, Vetiver, Typha Latifolia, Domestic wastewater, Filtration, Multimedia filter.**

1. INTRODUCTION

Water is considered as the most important and priceless commodity on planet Earth. Water is the reason we have life on earth, it is one of the most essential things that is required for every living being.

About 70 percent of the earth is water, but only one percent of it is accessible surface freshwater. Water crisis is the biggest crisis the world is facing today. In India the crisis in is very severe and it affects about one third of its people. According to an estimate in 2000, there were 7,800 cubic meters of fresh water available per person annually and It is said to be 5,100 cubic meters (51,00,000 litters) by 2025. This amount can also be is sufficient for human needs, provided it were distributed properly. But equitable distribution is not possible India, as it has 16 percent of the world's population, but only 2.45 percent of the world's land area and only about4 percent of the world's water resources. Water is the single largest problem India is facing today. Due to the rapid population growth and increasing rate of water consumption for agriculture, industry and municipalities and other areas have strained the fresh water resources.

In many parts of our country we our facing serious problems like chronic water shortage, loss of arable land, destruction of natural habitats, degradation of environment, and widespread pollution which undermines the public health and threatens the economic and social progress of our nation. In the developed countries, for example, the United Kingdom spends close to $60 billion for wastewater treatment plants. The World Bank has estimated that over the next decade other countries like the US will also spend about 800 billion to meet the total demand for fresh water, which includes sanitation, irrigation and power generation.

1.1 Objectives of study

This study is conducted to achieve the following objectives:

- Analyze and characterize the grey water.
- To collect and treat the domestic waste water from DMICE hostel mess.
- Investigate the feasibility of applying a constructed wetland system to treat the grey water.
- To determine the efficiency of constructed wetland system.

2. LITERATURE REVIEW

Many "natural systems" are being given consideration for the purpose of wastewater treatment and water pollution control. The interest in natural systems is based on the conservation of resources associated with these systems as opposed to the conventional wastewater treatment processes which are intensive in regards to the use of both energy and chemicals. Wetlands are one of the many types of natural systems that can be used for treatment and pollution control.

A constructed wetland is defined as "a wetland specifically constructed for the purpose of pollution control and waste management, at a location other than existing natural wetlands." Subsurface Flow (SF) wetlands are a commonly used type of constructed wetland. SF wetlands are characterized by the growth of emergent plants using soil, gravel, or rock as a growth substrate in a lined channel or bed. Within the bed, facultative microbes attach to the media and plant roots, thereby contacting the wastewater that flows horizontally through the bed while remaining below the surface of the media

Constructed wetlands offer the treatment benefits of natural wetlands in a more controlled environment. In many regards however, constructed wetlands are difficult to maintain and control. Many factors, such as the availability of oxygen, the clogging of wetland media, and the inability to adequately remove solids from the wetland by pumping lead to this lack of control and make the prediction of long-term treatment efficiency of SF wetlands difficult. Because of this lack of control, SF wetlands may not always be capable of producing an effluent that meets all discharge permit requirements. This makes the wetlands an unattractive treatment option in certain situations. Some of the advantages are:

1. Minimal energy requirements
2.Minimal maintenance requirements
3. Less-complex operation than conventional treatment processes
4. Minimal working expenses

2.1. Semi natural system for treating wastewater

Pond and vegetation come under semi natural system for treating wastewater. Wastewater treatment ponds, also known as waste stabilization ponds, are one of the world's most used waste water treatment method that does not require large space for its construction. This method is not only economical but also environmentally friendly. This has been an added advantage for treating wastewater and producing a highly purified effluent.

Wastewater treatment ponds are known to have advantages over other forms of wastewater treatment, especially in the ability to remove harmful pathogens and reduce organic pollutants (WHO, 1987). High quantities of organic pollutants can cause eutrophication, a significant environmental problem, in natural water systems which will in turn affect the removal of the organic pollutants of wastewater

Wastewater Treatment ponds are designed to stabilize wastewater before it is released into a natural water body or recycled. The ponds involve biological and chemical processes where the effluent's organic pollutants, the organic load, are broken down primarily through bacteria of the organic matter as a source of food. Treatment ponds are also capable of removing heavy metals **(Bowmer, Dunbabin,1990),** harmful pathogenic organisms **(Sperling, 2007)** and nutrients like nitrogen and phosphorous **(Sperling, 2007).**

There are many if these types of ponds that can be designed as well as utilized in treatment and the application of each one depends on the quantity of pollutants in the wastewater. These ponds include: facultative, anaerobic, aerated lagoons, complete, mixed lagoons and maturation ponds. Some can be used individually if there is not a high amount of pollutants in the wastewater whereas in other cases ponds are used in conjunction with other treatment process. The Climate, particularly temperature, in the region of the treatment ponds also play a key role in the possible treatment and therefore also in the design **(Parawira,2004)**

2.2 Vegetation for treating wastewater

The treatment done on land is one of the alternative means where wastewater is treated then disposed. It is basically the application of partially treated water to the land that is first designed and secondly constructed. The operation is simple and is an easy way to treat wastewater by the use of crops along with other irrigation methods, ground and surface water monitoring to conform to specific water quality limits. Therefore, this recycles waste water can be used for the irrigation of trees and watering gardens etc.

The species like typha latifolia are basically reed plants which have longer growing seasons and deeper, longer lasting root system than annual crops, which enables them to have a better utilization of the nutrients from wastewater.

The net effect is the beneficial systems that provide effective waste remediation and recycling of water and nutrients. The use of domestic wastewater emanating from these communities on fast growing plant species can be an effective way of wastewater treatment. Surface flow constructed wetland appear similar to natural swamp areas in which plants are rooted in a submerged layer of sand and gravel. We have applied surface flow constructed wetlands as the flow rates were highly unpredictable

2.3 Reed plant used in this experiment - TYPHA LATIFOLIA

Reeds are basically coarse grasses that grow in wet places. Reed bed is one of the natural and cheap methods of treating domestic, industrial and agricultural liquid wastes. Reed bed is considered as an effective and reliable secondary and tertiary treatment method where land area is not a major constraint.

Application of root zone technology (RZT) is finding wider acceptability in developing and developed countries, as it appears to offer more economical and ecologically acceptable solution to water pollution management problems. These are reported to be most suitable for schools, hospitals, hotels and for smaller communities. The country's reportedly first RZT system was designed by NEERI at Sainik School; Bhubaneshwar, Orissa. It has reportedly been giving a very good performance of removing 90% BOD and 63% nitrogen .The objective of this work is to analyze the Grey water generated and evaluate the suitability and effectiveness of treating effluents by root zone system by vertical and horizontal Root zone system thereby to compare the results.

Typha latifolia also known as Cattail, is actually a thin aquatic plant that grows throughout the year in any climatic condition. The plants used in wetland systems are known as emergent hydrophytes and macrophytes. The major portion of these plants (leaves and flowers) emerge above the media surface and are exposed to the air, while their roots and rhizomes are submerged beneath the water and media (Kadlec and Knight, 1996). Three of the commonly used plant species in SF wetlands are bulrush (Scirpus), reeds (Phragmites), and cattails (Typha). It has been shown that Iris, sp. did not grow as vigorously as other plant types under simulated SF wetland conditions (Neralla et al., 1999). One role that is beyond debate is the aesthetic appeal that wetland plants provide by covering the wetland bed and controlling odours

The wetland plants provide a habitat to many animals, including small mammals and birds. The plant cover also limits the amount of ponding water on the bed surface that serves as breeding environments for nuisance insects such as gnats and mosquitoes (Wood, 1995). Plant roots and rhizomes provide surfaces for microbial growth and also aid in the filtration of solids (Wood,1990). However, the other plant function in SF systems have led to many problems in both design and operation. A major premise of the root-zone method is that the wetland plants are able to provide oxygen to the heterotrophic bacteria in the rhizosphere thereby allowing aerobic degradation of organic matter and nitrification to occur (Brix, 1987). It is not debatable that oxygen is transferred from the aboveground parts of the plants through airways to the roots and rhizomes.

Without oxygen the wetland plants would not be able to survive and grow. The question arises as to whether the amount of oxygen provided is in excess of the amount required by the plants. It was proposed that aerated microzones are developed around the roots and rhizomes by the leaking of oxygen through these structures (Brix, 1987). These oxidized areas in an otherwise anaerobic environment provide conditions in which the aerobic biological transformations occur. Many design approaches are based on the fact that significant aerobic biodegradation of organic wastes and nitrification take place in these microzones.

It was stated by Hiley et al., (1995) that the only situations in which plant roots and rhizomes are likely to leak any significant amount of oxygen into the rhizosphere are ones in which the oxygen demand is relatively low. It is very rare to encounter low oxygen demand conditions in SF wetlands treating wastewater, therefore from a quantitative view, the amount of oxygen provided to the surrounding media by roots and rhizomes is minimal. The respiration and growth of the wetland plants appear to require almost all of the oxygen transported to the root zone (Kadlec and Knight, 1996).

The oxygen provided to the wetland is taken up through the surface of the water (Hiley et al, 1995), and is dominated by air-water-media interfacial transfer (Kadlec and Knight, 1996). The implication of this is that only the very top portions of the wetland bed experience aerobic conditions. The resulting anaerobic conditions throughout the rest of the root zone bed and their impact on treatment performance will be discussed in a later section

The second questionable role of plants in SF wetlands is their ability to increase or stabilize the hydraulic conductivity of the media (Brix, 1987). This is of particular importance when utilizing a small sized media such as soil. By disturbing and loosening the soil, the growth of plant roots and rhizomes will increase the porosity of a soil thereby allowing less hindered flow

Fig2.3 TYPHA LATIFOLIA

2.4 Root zone method

The root zone method (RZM) is generally accepted and used as the basis for the design of SF wetland systems. Wastewater then flows horizontally through the media filled channel where it is treated by physical, biological, and chemical processes. These processes are said to take place in the rhizosphere, which is composed of the media, the plant roots, the plant rhizomes, and the associated microbial communities (Conley et al., 1991). After treatment, the wastewater is collected in the outlet zone and directed to further treatment processes or to discharge into a waterway. Each component within the root zone bed plays a role in the system, however there are varying views as to the significance of those roles to the overall functioning of the treatment configuration.

2.5 Microorganisms

A large consortium of facultative microbes' lives attached or associated with the media and plant roots. Although much of the treatment that is expected from SF wetlands is based on microbial degradation, a lack of knowledge is evident regarding the exact mechanisms that account for these processes. Based on the discussion earlier dealing with the limited availability of oxygen, aerobic respiration is limited to the upper portions of the wetland bed, and anaerobic metabolism dominates the remaining portion of the bed. Because nitrate is not readily oxidized in largely anaerobic systems, the presence of anoxic conditions and the microbes thriving under anoxic conditions is minimal

3. MATERIAL USED

The materials used in this experiment are easily available and can be used extensively even on large scale filters. The types of media, sizes, surface porosity and roughness of filter media directly impact the efficiency of the multimedia. Therefore, in order to obtain the higher removal efficiency a suitable filter media should be selected and designed. A filter media is one of the chief components in the multimedia filter system due to its large surface area that will enhance the microbial growth. The medias of varying sizes such as plastic scrubbers, chrysopogon zizanioides (vetiver) and Muslin cloth along with a basic sand filter of varying sizes were used in the present study.

3.1 MEDIAS

1. chrysopogon zizanioides (vetiver)

2. *Chrysopogon zizanioides*, commonly known as vetiver .

3. Muslin cloth
4. Plastic scrubbers

5. Basic sand filter

4. EXPERIMENTAL SET UP

4.1 Process description

Filtration is the process of passing water through material to remove particulate and other impurities, including floc, from the water being treated. These impurities consist of suspended particles (fine silts and clays), biological matter (bacteria, plankton, spores, cysts or other matter) and floc. The material used in filters for public water supply is normally a bed of sand, coal, or other granular substance. Filtration processes can generally be classified as being either slow or rapid

4.2Set-up

The aim of the study is towards designing Low-cost filter model and treatment of domestic waste water by filtration process using low-cost adsorbents and study the performance of multimedia filter with different packing media along with the constructed wetland. It is based upon the concept of attached growth process. The model was fabricated with a plastic tank which has a capacity of 1000liters. it has a height of 1m. and length of 1.2m.. The domestic wastewater was fed into the reactor, after partial treatment due to the wetland process it enters the second layer containing vetiver and scrubbers and then to the third layer contains a sand filter of gravel, stones and sand particles of varying sizes. The wastewater thus rises evenly at the same time it gets treated. The treated water is then collected at the end.

5.RESULTS

During the study, the effluent was collected and was analysed for various parameters such as pH, BOD, COD and TS. Throughout the study the constructed wetland along with the multimedia filter was operated for varying detention time of 18hrs, 21hrs and 24hrs and samples were collected with a gap of 25 days in between. It was observed that removal efficiency for BOD was 70%, COD was 60% and TS was 80% and the values are listed out in tables below. The multimedia filter process gave best results for TS removal.

5.1 Concentration of various parameters before treatment.

The Grey water is collected and before letting to the Horizontal surface flow root zone the various parameters are tested. The values so obtained are tabulated

BEFORE TREATMENT

S.No	PARAMETERS	DAYS				
	SAMPLE (days)	5	25	50	75	100
1	pH	7.5	8.2	8	7.3	7.46
2	BOD (mg/l)	92	90	89	116	132
3	COD (mg/l)	440	400	520	448	436
4	TS (mg/l)	704	732	740	605	754
5	TURBIDITY	139	140	143	142	141

5.2 Concentration of various parameters After treatment.

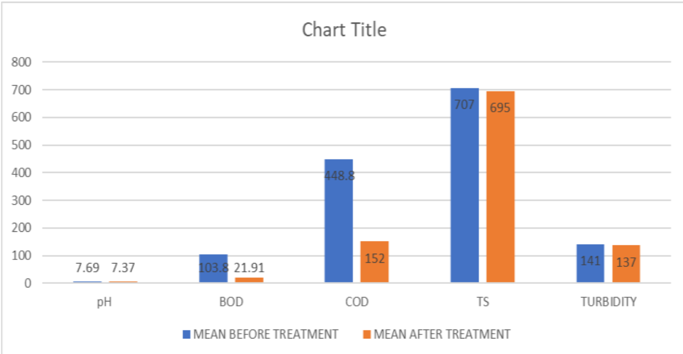
The treated water obtained from the Horizontal subsurface flow root zone were collected and then various parameters are tested. The values so obtained are tabulated

AFTER TREATMENT

S.No	PARAMETERS	DAYS				
	SAMPLE (days)	5	25	50	75	100
1	pH	7.2	7.65	7.9	7	7.1
2	BOD (mg/l)	17.5	23.5	24	19	25.4
3	COD (mg/l)	240	200	260	280	216
4	TS (mg/l)	391	307	335	455	575
5	TURBIDITY	29	28	25	26	29

5.3 Comparison of various parameters

PARAMETER	MEAN BEFORE TREATMENT	MEAN AFTER TREATMENT
pH	7.69	7.37
BOD	103.8	21.91
COD	448.8	152
TS	707	695
TURBIDITY	141	137



5.4 Discussion

The results show the concentration of five parameters for Grey water treatment by Horizontal surface flow root zone. It is clear that there is a remarkable reduction in pH, B.O.D, C.O.D by Reed bed treatment and the treated water has become fit enough to be let out directly into a g water. Thus, the root zone treatment can be used independently or as an addition to conventional treatment so as to make the final output fit enough for discharge into a natural water body. During the starting stage the root zone system shows quite low efficiency in B.O.D and C.O.D due to minimum growth of the plant. In the later stage the root zone bed showed greater efficiency.

Multi-media filters are the recent development in the filtration technology which involves the use of multiple media other than the conventional media as opposed to sand used in the conventional sand filters. It can also be concluded from the study that the multimedia filter may be considered as efficient treatment process for domestic wastewater. Also, the above media may enhance the performance of the treatment system. Hence this technology is environment friendly and cost effective. Treated water can be used for Irrigation, toilet flushing, car washing, gardening, firefighting, etc

6.CONCLUSION

The Grey water was analyzed to determine its characteristics. The root zone method (constructed wetland) was employed to treat the Grey water. Based on the experimental results, the following conclusions are made.

1. This study demonstrated that the designed surface horizontal flow constructed wetland system could be used for treatment of the Grey water.
2. Regarding the performance achieved, the surface horizontal flow constructed wetland was able to reduce further the level of the main physicochemical pollution parameters. Therefore the plants play a very important role in the treatment of the wastewater.

3. The treatment level was affected by not only by the change of seasons, but also by the variation in influent quality and quantity.

4. The overall experimental results demonstrated the feasibility of applying surface horizontal flow constructed wetland unit to treat Grey water. Thus, the root zone treatment can be utilized independently or as an addition to conventional treatment for complete treatment of Grey water.

5. It can be also concluded that vetiver, plastic scrubbers and muslin cloth along with a basic sand filter shows a noticeable improvement of adsorption of oil and greases from polluted water significantly assist in the removal of pH, TDS, BOD, COD, TSS, and will improve the physio-chemical quality of the effluent.

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