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REVIEW OF CONSTRUCTED WETLAND FOR WASTE WATER TREATMENT

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ABSTRACT:

There is a great lack of proper wastewater treatment in developing countries. Due to the financial situation and to the less stringent standards, wastewater sewerage and treatment are not properly developed in developing countries. Constructed wetlands are a natural alternative to technical methods of wastewater treatment. Constructed wetlands are among the recently proven efficient technologies for wastewater treatment. Compared to conventional treatment systems, constructed wetlands are low cost, are easily operated and maintained, and have a strong potential for application in developing countries, particularly by small rural communities. However, these systems have not found widespread use, due to lack of awareness, and local expertise in developing the technology on a local basis. In general, constructed wetlands can be designed to remove more than 90% of BOD, COD, suspended solids and bacteriological pollution from the through-flowing wastewater. Removal of Nitrogen and Phosphorus remains, however closer to 50% in most cases. This report further examines the potential of constructed wetlands for wastewater treatment and reuse in developing countries.

KEYWORDS: *Wastewater, Treatment, Wetland, BOD, COD.*

1. Introduction

The world is urbanizing rapidly. At present 60% of the world's population lives in urban Areas and worldwide it is estimated that by 2025 more than 90% of the population growth Will take place in urban areas. As urban population increases, the Surrounding rural areas will also quickly develop. Water and sanitation for all is one of the Major challenges in these areas. Finding ways to satisfy human water demand ranks among the most critical and difficult challenges of the 21st century. Most large cities are already facing water supply problems and these will only increase in the future. Rural and non sewered areas often have to deal with the unsatisfactory performance of the Conventional onsite wastewater treatment system. Conventional onsite Systems usually consist of septic tanks, leachfields and sand filters. Inadequate treatment of Domestic wastewater in these areas can contribute to the pollution of surface water and Ground water. The nutrients and pathogens in human waste may Impair water of streams and threaten public health. So there is a need of onsite treatment Alternatives to conventional systems which can solve these potential problems, and which are Practical, affordable, effective, simple, reliable, and environmentally friendly. Small scale Systems have the capacity to make waste treatment more sustainable. Small scale sanitation Systems keep the nutrient and water cycle small, making use of recovered waste more Practical and cost effective.

There is a wide range of small scale onsite treatment technologies; Constructed Wetland is one of them. Constructed Wetlands have grown in popularity since early 1980s. Where Land is available, Constructed Wetland systems will often provide the most cost effective and practical Wastewater treatment alternative. The use of Constructed Wetlands for treatment of Domestic wastewater has increased exponentially in the past decade, especially for small Scale applications such as individual homes and small communities. Many urban areas around the world have already used this approach. If well designed and maintained, their effluents can meet the high standards required for reclaiming the water. Reuse of wastewater for non-potable use like irrigation, toilet flushing, Laundry etc can reduce demand on limited fresh water resources.

2. LITERATURE REVIEW

2.1 History and Present Scenario of Constructed Wetlands

Wetlands commonly known as biological filters have emerged as a viable option for helping to solve a wide range of environmental and water quality problems (Greenway and Simpson, 1996; 1997a,b). The use of constructed wetlands is a relatively new technology but the system is gaining popularity due to its low tech system for treating wastewater (DeBusk et al., 1996). In the past several decades, constructed wetlands have become a popular option for wastewater treatment and have been recognized as attractive alternatives to conventional wastewater treatment methods. This is due to their high pollutant removal efficiency, easy operation and maintenance, low energy requirements, high rates of water recycling, and potential for providing significant wildlife habitat. Wetland systems are one of the few technologies that can produce a biologically treated effluent (to secondary or better standards) with sufficiently low pathogen content. Wetland systems can achieve this level of treatment with minimal external labor or energy input and operator support. This system can be constructed from local material and is easy to operate and maintain, so they have the potential for widespread applications in developing countries like India. (Wallace and Knight, 2006).

2.2 Components of a Constructed Wetland

The design components of a Constructed Wetland are unique to its location. Once thehydrological design aspects are complete, the design of the actual structure can begin. A Constructed Wetland is made up of three components:

1. A basin containing water

2. A substrate

3. Plant life

A basin can be constructed by using the topography of the land and various grading operations. During the construction of a wetland it is important to remember that the soil lining the wetland be relatively impermeable. This will keep the effluent collected within the basin from seeping into the ground. Lastly, the location and size of the basin should be relative to the topography of the land and drainage area, meaning the wetland should be in a location where it can effectively collect and accommodate the amount of effulent collected (Davis).

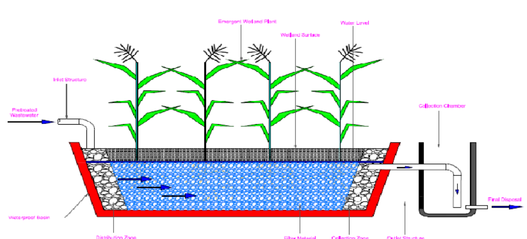

Figure 2.1: Components of Constructed Wetlands

2.3.1 Plant used in Wetland

- **Emergent Aquatic Macrophytes**

These are the dominating life form in wetlands and marshes, growing within a water table range from 50 cm below the soil surface to a water depth of 150 cm or more. In general they produce aerial stems and leaves and an extensive root and rhizome-system. The plants are morphologically adapted to growing in a water-logged or submersed substrate by virtue of large internal air spaces for transportation of oxygen to roots and rhizomes. This life form comprise species like Phragmites australis (Common Reed), Glyceria spp. (Mannagrasses), Eleocharis spp. (Spikerushes), Typha spp. (Cattails), Scirpus spp. (Bulrushes), Iris spp. (Blue and Yellow Flags) and Zizania aquatica (Wild Rice).

- **Floating-Leaved Aquatic Macrophytes**

These includes both species which are rooted in the substrate, e.g. Nymphaea spp. and Nuphar spp. (Waterlilies), Potamogeton natans 4 (Pondweed), and Hydrocotyle vulgaris (Pennyworth), and species which are freely floating on the water surface, e.g. Eichhornia crassipes (Water Hyacinth), Pistia stratiotes (Water Lettuce) and Lemna spp. and Spirodella spp. (Duckweed). The freely floating species are highly diverse in form and habit, ranging from large plants with rosettes of aerial and/or floating leaves and well-developed submerged roots (e.g. Eichhornia, Trapa, Hydrocharis), to minute surface-floating plants with few or no roots (e.g. Lemnaceae, Azolla, Salvinia).

- **Submerged Aquatic Macrophytes**

These have their photosynthetic tissue entirely submerged but usually the flowers exposed to the atmosphere. Two types of submerged aquatics are usually recognised: the elodeid type (e.g. Elodea, Myriophyllum, Ceratophyllum), and the isoetid (rosette) type (e.g. Isoetes, Littorella, Lobelia).

3 PRELIMINARY STUDY METHODOLOGY

3.1 Chemicals, Glassware and Instruments Required

All glassware used was of Borosil make and the instruments used for conducting different tests were listed in the Table 3.1. All the chemicals used were either of analytical grade (AR) or laboratory grade (LR).

Instrument /Equipment	Parameter Tested/Measured
COD Digester	COD
Digital pH Meter	pH
BOD Incubator	BOD
Electronic Balance	Weight
Muffle Furnace	VSS
Oven	SS, Drying
Spectrophotometer	For measuring COD

Table 3.1 Instruments used for the analysis

3.2 Consumables

Filter paper: Whatman glass fiber filter paper No. 42 (pore size 0.45μm) was used for the analysis of suspended solids (SS) and volatile suspended solids (VSS). A4 size sheets were cut into circles of 47 mm diameter for the analysis.
Distilled water: Distilled water, prepared from glass distillation, was used for preparing standard solutions and for rinsing glassware after cleaning. Distilled water was having an average pH of 6.80 ± 0.1, average hardness 0.6 mg/L, chlorides 1.3 mg/L, and conductivity 2μs/cm.

3.3 Analytical Methods

Different analytical techniques and methodologies used for present investigation have been described. In general, standard techniques as detailed in standard methods (APHA, 1998) have been followed unless otherwise specified.

- **The pH**

The pH was measured using digital pH meter with a sensitivity of 0.01 and having temperature correction facility. The ph was measured by placing electrode in the sample. The instrument was calibrated periodically with standard buffer solutions. This analysis was done to monitor the health of biological process, as excessive fermentation will produce acids, which may alter the process performance.

- **Alkalinity**

As there was no hydroxide alkalinity in the synthetic or actual sewage, bicarbonate alkalinity in the sewage was determined using titrimetric method. 20 ml of ordinarily filtered sample was taken in conical flask and 2 to 3 drops of methyl orange indicator was added. The solution was titrated with 0.02 N H_2SO_4 solutions until the colour of solution changes from yellow to pinkish orange, which is end point of titration.

- **Suspended Solids (SS) and Volatile Suspended Solids (VSS)**

Appropriate sample was taken based on suspended solids present in the sample. The sample was filtered through initially dried 0.45μm whatman glass fiber filter paper at 105º C, cooled in dessicator and weighed. The filtration was carried out using vacuum filtration apparatus. Again the filter paper was dried at 105 ºc, cooled down to room temperature in dessicator. The increase in weight represented suspended solids and it is expressed as mg/L. The weighed filter paper with sample was put in muffle furnace at 550 ºc for 15 to 20 minutes, cooled down in dessicator, and weighed. The weight loss on ignition is expressed as volatile suspended solids. To avoid any loss of weight during handling, porcelain crucible was used along with filter paper. The effluent SS and VSS were determined once in a week

- **Biochemical Oxygen Demand (BOD)**

The sample is filled in an airtight bottle and incubated a 20^0 C for 5 days. The dissolved oxygen (DO) content of the sample is determined before and after five days of incubation at 20^0 C and the BOD is calculated from the difference between initial and final DO.Take about 300-400 ml of dilution water in a1000 ml jar and add the nutrients phosphate buffer, $MgSO_4$ $CaCl_2$ and $FeCl_3$ 1ml each.

Mix the jar contents vertically without aerating. Fill up three BOD bottles A, B & C with the diluted sample. Keeping the bottles B & C in the incubator maintained at 20^o C and immediate DO of bottle A is calculated. After 5 days, determine DO of incubated samples in bottles B & C. BOD is calculated from the difference between initial and final DO.

- **Chemical Oxygen Demand (COD)**

Closed reflux colorimetric method was used for analysis. Refluxing was done for 2 hrs in capped hach tubes with potassium dichromate in a hatch digester, and the oxygen consumed was measured against standards at 600 nm with a spectrophotometer as given in the Table 3.1. For experiments using synthetic sewage the settled effluent COD was measured with a settling time of 20 to 30 minutes, and raw influent was used for COD analysis. Whereas, for actual sewage, settled COD for both influent and effluent was taken. The COD determination of influent and effluent to ML-MFCs was carried out every alternate day.

- **Total Dissolved Solids (TDS)**

Total solids are determined by evaporating a known volume of the sample to the sample to dryness and weighing the residue. Dissolved solids are determined by filtering a known volume of the sample, evaporating the filtrate to dryness and weighing the residue. To determine TDS weigh a clean and empty crucible (A). Taking known volume of the sample, filter it through Whatman filter paper no .40 and collect the filtrate in (A). Evaporate the filtrate in (A) to dryness in hot air oven at 103° -105°C. By cooling the crucible to room temperature and weighing.

4 FUTURE SCOPE:

The use of Constructed Wetlands for sewage treatment at different levels is commonly known. However, they have also been applied for the treatment purpose of different types of wastewater. Constructed wetlands are a natural alternative to technical methods of wastewater treatment. Constructed wetlands are among the recently proven efficient technologies for wastewater treatment. Compared to conventional treatment systems, constructed wetlands are low cost, are easily operated and maintained, and have a strong potential for application in developing countries, particularly by small rural communities.

5CONCLUSIONS

The monitoring of horizontal flow constructed wetland shows that the general performance of the system was good and it successfully reduced contaminants even under fluctuating contaminant loading resulting from power breakdown. The results indicate that if constructed wetlands are appropriately designed and operated, they could be used for secondary and tertiary wastewater treatment under local conditions, successfully. Hence constructed wetlands can be used in the treatment train to upgrade the existing malfunctioning wastewater treatment plants, especially in developing countries. The treated wastewater from these wetlands can be used for landscape irrigation and also for other beneficial uses.

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