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Constructed Wetland and Its Perspective- A Review

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Abstract— The majority of disease spreads through the sources of water and the waste produced should to be treated before it is finally disposed-off in the open or in the natural water body for its further purification by self-purification process. In the area where there is unavailability of the treatment plant for the treatment in wastewater treatment plant as the cost of construction is very high and in such cases the water is directly thrown in the open land and this wastewater reaches the underground water table and contaminating the whole aquifer of the water present in that area and as there is unavailability of water treatment plant so people in such areas use the underground water directly causing various water borne disease. In such areas where the cost is one of the major factor, there the constructed wetland can be use very effectively as the cost of construction and maintenance is very low and can serve as an effective mean of treatment of domestic waste water.

Keywords— wastewater, constructed wetland, low cost treatment, types of constructed wetland,

INTRODUCTION

Wetland which can be either a natural or artificial is a cheap and low cost treatment alternative treatment of the wastewater mainly for small communities as treatment and maintenance cost is low[12][13][2]. A constructed wetland is a artificially designed system used for the improvement of the wastewater quality parameter before it is finally discharged in the open or natural stream. Earlier the number of such system was very limited as there was not enough research data is available and as the research in the world continues the no. of number of such plant has increased where it was first used in the pilot scale was in the 1960. Even the treatment plant construction is limited in the developing countries as the cost of construction and the maintenance cost is high and this focus our attention to the constructed wetland system for improving the receiving water quality, water reclamation and reuse is currently the driving force for the implementation of the artificially constructed wetland all over the world. Constructed wetlands has emerged as an alternative to the conventional wastewater treatment plant, which can be used as part of decentralized wastewater treatment systems and are a robust and "low tech" technology with low operational requirements [6][7][8][10].

Recently for our development work to fulfil the needs of the pubic and there is being reduction in the number of natural wetland in the world whose consequences can be seen as there is no control for flooding and has totally destroyed the function and the values of the natural wetland in the world.

The number of CWTS for use has very much increased in the past few years. Constructed wetlands are now proves a viable source for the wastewater treatment as its result shows from the various researchers in this field. Most of these systems cater for tertiary treatment from towns and cities. They are larger in size, mostly using surface-flow system to remove low concentration of nutrient (N and P) and suspended solids.

Typically, wetlands are constructed for one or more of four primary purposes: creation of habitat to compensate for natural wetlands converted for agriculture and urban development, water quality improvement, flood control, and production of food and fibre (constructed aquaculture wetlands).

TYPES OF CONSTRUCTED WETLAND SYSTEM

Constructed wetland is classified into two types:

1. Horizontal flow system and
2. Vertical flow system

Horizontal flow system has two types:

a. Surface flow system and
b. Sub-surface flow system

In horizontal flow system the water is passes into inlet and passes horizontally through bed to the outlet point.

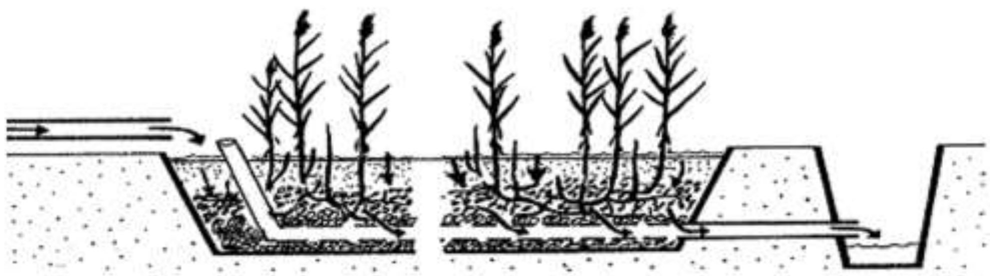

Fig.1 Subsurface horizontal flow wetland system

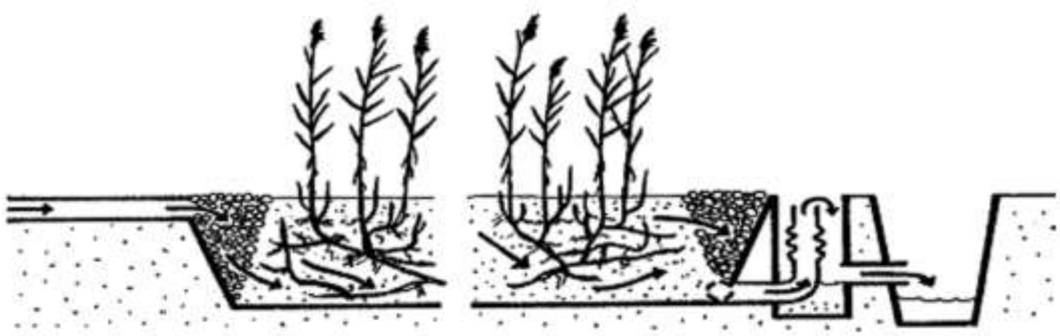

Fig.2 Subsurface vertical flow wetland system

Surface Flow System:

In this type the influent water flows across the basin which supports the vegetation and water is clearly above the substrate material, the material can be locally available soil or clay which act as a impervious layer. These systems are used for the treatment of the municipal domestic waste water as quantity of flow is more and this act as a polishing for the nutrient. The depth of this bed is about 0.4m.

Sub-Surface Flow System:

In this system the wastewater flows one point to other through permeable substrate which can be a mixture of gravel and soil, which support the roots of the plant called as root-zone method or rock-reed method or emergent vegetation bed system. The depth of this medium is more than the surface flow system i.e about 0.6m. the free water is not visible in this type

CONSTRUCTION OF WETLAND SYSTEM

The construction of wetland treatment system is divided into constructed wetland creation and plantation of vegetation. For construction of constructed wetland land is cleared for site preparation followed by construction of wetland and then installation of water control system.it should be seen that while clearing the site all the vegetation are removed with all the roots in the soil.

The wetland is provided with slope, then there is construction of wetland cell berms by compacting soil and installing of liners. Final site grading consists of levelling the wetland cell bottom to optimise the spreading of wastewaters in the completed wetland. The wetland cells are flooded to a 'wet' condition for planting. Wetland plants are transferred to the site and planted manually. After plants are established, water levels are gradually increased to normal water levels, and wetlands are completely created.

ROLES OF WETLAND PLANTS IN WASTEWATER TREATMENT

Plant plays a significance role in the treatment of the wastewater in relation to the water purification which brings about the physical effect due to the plant. The plant provides large surface area for the growth and attachment of microorganisms. The physical component of the plant stabilize the surface of the bed, slow down the flow of water and thus helps in sediment settling and increasing the visibility of the water.

Hollow vessels of the plant tissues enable to transport oxygen from the leaves to the root zone and to the surrounding soil [1][5]. Because of this the active decomposition of aerobic micrbial take place and the uptake of pollutants from the water system to take place.

The role of wetland plants in a constructed wetland systems is divided into 6 categories:

A. **Physical -** Macrophytes stabilise the surface of plant beds, provide good conditions for physical filtration, and provide a huge surface area for attached microbial growth. Growth of macrophytes decreases the velocity of flow of wastewater which further results in sedimentation and there is increase in contact time between effluent and surface area plant thus, there is increase in the removal of Nitrogen.

B. **Soil Hydraulic Conductivity** - Soil hydraulic conductivity is improved with the emergent plant bed system. The root mass creates macropores in constructed wetland soil system which allows for increase in percolation of water, thus increasing effluent and plant interactions with each other.

C. **Organic Compound Release -** Plants releases a wide variety of organic compounds through their root systems, with rates increase up to 25% of the total photo synthetically fixed carbon. The carbon released act as a source of food for denitrifying microbes[6]. Decomposion of plant biomass provides a durable, readily available carbon source for the microbial populations.

D. **Microbial Growth -** Macrophytes are above and below the ground and biomass provides a large surface area for growth of microbial biofilms. These biofilms are responsible for a maximum of the microbial processes that take place in constructed wetland system, including Nitrogen reduction [6]. The Plants create and maintain the layer of humus that is like a thin biofilm. When the plants grow and die, the leaves and stems falling to the surface of the substrate create number of layers of organic debris. This accumulation of partially decomposed biomass creates a porous substrate layers that provide a substantial amount of attachment surface for microbial organisms. The water quality improvement in constructed and natural wetlands is related to and dependent upon the high conductivity of the humus layer and the large surface area for microbial attachment.

E. **Creation of aerobic soils -** Macrophytes provides transfer of oxygen through the hollow plant tissue and leakage from root systems to the rhizosphere where aerobic degradation of organic matter and nitrification take place.fig.3 Wetland plants adapted with the suberized and lignified layers of the hypodermis and outer cortex to minimise the rate of oxygen leakage.

The high Nitrogen removal of Phragmites is most likely attributable to the characteristics of its root growth. Phragmites allocates 50% of plant biomass to the root and rhizome systems. Increased root biomass allows for greater oxygen transport into the substrate, creating a more aerobic environment favouring nitrification reactions. It is evident that the rate of nitrification is most likely the rate limiting factor for overall Nitrogen removal from a constructed wetland system [11].

F. **Aesthetic values -** The macrophytes provides a site-specific aesthetic values by providing the habitat for wildlife and making wastewater treatment systems pleasing.

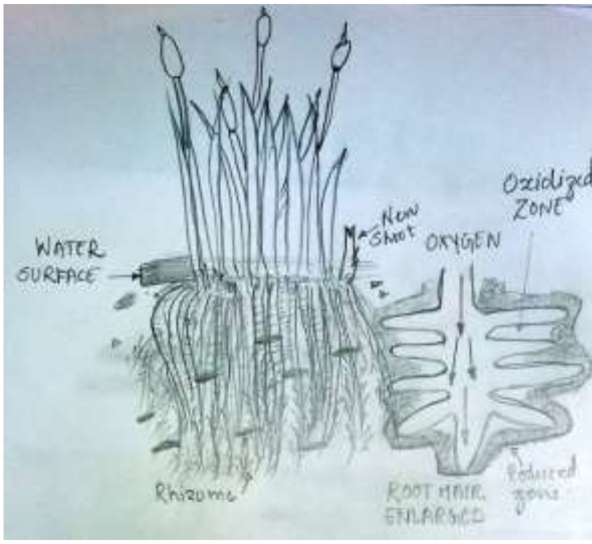

Fig.3 Roots of marsh plant

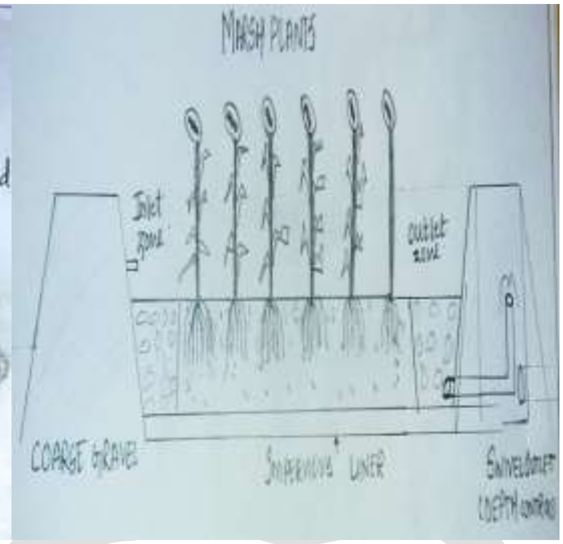

Fig.4 configuration of sub-surface flow system.

SELECTION OF WETLAND PLANT

Depending on the conditions of various types of plant griwn are :common reed (Phragmites australis), rush (Typha latifolia), iris, as shown in fig. 3 these plant are stable towards the climatic changes and the type of medium in which it is grown. The Floating and submerged plants are used in the aquatic plant treatment system. A wide range of aquatic plants have proved their ability to assist in breakdown of wastewater. The Water Hyacinth (Eichhornia crassipes), and Duckweed (Lemna) are common floating aquatic plants which have shown their ability to reduce concentrations of BOD, TSS and Total Phosphorus and Total Nitrogen. But due to prolonged presence of Eichhornia crassipes and Lemna it can result in deterioration of the water quality so these plants have to be removes from the system. The floating plants produces a massive layer that will obstruct penentration of light to the lower layer of the water which affect the life of the living water organisms. This system is colonised rapidly with one or only a few initial individuals. The system needs to be closely monitored to prevent attack from these nuisance species. Loss of plant cover will impair the treatment effectiveness. Maintenance cost of a floating plant system is high. Plant biomass should be regularly harvested so as to ensure significant nutrient removal. Plant growth also needs to be maintained at optimum rate to maintain treatment efficiency. The Common Reed (Phragmites spp.) and Cattail (Typha spp.) are examples of emergent species which are used in constructed wetland treatment systems. Plant selection is quite similar for SF and SSF constructed wetlands. Emergent wetland plants grow best in both types of the systems. These emergent plants play a vital role in the removal and retention of nutrients in a constructed wetland. Although emergent macrophytes are less efficient in lowering Nitrogen and Phosphorus contents by direct uptake due to their lower growth rates (compared to floating and submerged plants), their ability to uptake Nitrogen and Phosphorus from sediment sources through rhizomes is higher than from the water.

Phragmites australis *Typha latifolia* *Scirpus lacustris* *Iris pseudacorus* *Glyceria maxima*

Fig.5 Different types of plants used in constructed wetland system (Silviya Lavrova et.al.,)

WETLAND MONITORING AND MAINTENANCE

Monitoring and maintenance of the wetland is one of the main parameter on which the functioning of the wetland depends. With continuous monitoring of the data obtained with the maintenance will result in success of the system. The maintenance can be like managing the plant of only desirable species and removing the unwanted weeds , this will result in the better efficiency of the filter medium and the overall performance will be boosted up. [3]

The effectiveness of the wetland also depends on the effectiveness of the pre-treatment, the rate of loading, the information obtain after monitoring will serve as a record for the proper running of the system. The CWTS system could be rather easy to design and construct, but it needs to be closely monitored and maintained.

Sustaining a dense plantation of desirable vegetation within the wetland is important to ensure that the treatment efficiency is effective. Aggressive plant species comes out to be less competitive and cause gradual changes in wetland vegetation. Some undesirable plant species or weeds may introduced to the wetland from the nearby vegetation. Natural succession of wetland plants will take place. However, there are some aquatic weeds which may require maintenance by removing it manually. The weed invasion can dramatically reduce the ability of wetlands to meet the design objectives. For example, Pondweed (Azolla), Duckweed (Lemna), Water Fern (Salvinia molesta) and Water Hyacinth (Eichhornia crassipes) can form dense mats, exclude light and reduce dissolved oxygen in the water column, and increase the movement of nutrients through the system. Water level management is also crucial to control weed growth.

Floods cause the plants to be scoured from the wetland and completely destroy the area. If a large area of plants is damaged then, re-establishment have to be carried out. Small areas generally recovers naturally while larger areas above 5 m2 may require replanting.

Plant viability is important to water quality improvement in wetlands. Visible signs of plant distress or pest attack have to be investigated on an regular basis. Some common pest insects like Lepidopterrous Stem Borers on Scirpus grossus, aphids on Phragmites karka and Leaf Roller on Phragmites karka. Severe infestation can lead to severe stunting and death of plants. Biopesticides or narrow spectrum-pest specific insecticides can be used if pest population exceeds a certain threshold value. Other pests include the Golden Apple Snail Pomacea sp, which feeds actively on wetland plants.

Water levels are important in wetlands with effects on hydrology and hydraulics. Water level should be monitored using water level control structures to ensure successful plant growth. A recirculation system should be in place to allow water from outlet points to be fed back to the wetlands to supplement catchment flows during dry periods. Suspended solids from effluents and litter fall from plants causes the accumulation in time and gradually reduce the pore space which need to be flushed to prevent short-circuiting. Monitoring of mosquito populations should be undertaken to avoid diseases, which can result in a local health problem.

CONCLUSION

The use of constructed wetlands to treat wastewater is relatively new in India. However, due to the impressive results achieved by the various researchers in this field have prompted a great expectations in the use of constructed wetland in treatment of wastewater. The wetlands can be used in as a sustainable technology, by clearly defining the objectives and the goal which we want to achieve with proper monitoring of the performance.

This system also creates an aesthetic environment as it provides the greenery in the area where it is being used and finally the water will be less polluted and will be safer even if they are disposed-off in the open and the unhygienic conditions will be removed and will serve as a habitat for flora and fauna.

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