INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH
A knowledge Repository

EFFICACY OF PHRAGMITE KARKA PLANT IN CONSTRUCTED WETLAND SYSTEM

Shalini Saxena
Govt. M.L.B. College Bhopal (M.P.)

ABSTRACT

Wetlands, either constructed or natural, offer a cheaper and low-cost alternative technology for wastewater treatment. A constructed wetland system that is specifically engineered for water quality improvement as a primary purpose is termed as a 'Constructed Wetland Treatment System' (CWTS). In the past, many such systems were constructed to treat low volumes of wastewater loaded with easily degradable organic matter for isolated populations in urban areas. However, widespread demand for improved receiving water quality, and water reclamation and reuse, is currently the driving force for the implementation of CWTS all over the world. Recent concerns over wetland losses have generated a need for the creation of wetlands, which are intended to emulate the functions and values of natural wetlands that have been destroyed. Natural characteristics are applied to CWTS with emergent macrophyte stands that duplicate the physical, chemical and biological processes of natural wetland systems. The number of CWTS in use has very much increased in the past few years. The use of constructed wetlands is gaining rapid interest. Most of these systems cater for tertiary treatment from towns and cities. They are larger in size, usually using surface-flow system to remove low concentration of nutrient (N and P) and suspended solids. However, in some countries, these constructed wetland treatment systems are usually used to provide secondary treatment of domestic sewage for village populations. These constructed wetland systems have been seen as an economically attractive, energy-efficient way of providing high standards of wastewater treatment by the help of Phragmite karka plant.
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 fiber.

Keywords:
CWTS, macrophyte,surface flow, domestic sewage, constructed wetlands.

INTRODUCTION

Constructed wetland treatment systems are a new technology for India. It is a cheaper alternative for wastewater treatment using local resources. Aesthetically, it is a more landscaped looking wetland site compared to the conventional wastewater treatment plants. This system promotes sustainable use of local resources, which is a more environment friendly biological wastewater treatment system. Constructed wetlands can be created at lower costs than other treatment options, with low-technology methods where no new or complex technological tools are needed. The system relies on renewable energy sources such as solar and kinetic energy, and wetland plants

and micro-organisms, which are the active agents in the treatment processes. The system can tolerate both great and small volumes of water and varying contaminant levels. These include municipal and domestic wastewater, urban storm runoff, agricultural wastewater, industrial effluents and polluted surface waters in rivers and lakes. The system could be promoted to various potential users for water quality improvement and pollutant removal. These potential users include the tourism industry, governmental departments, private entrepreneurs, private residences, aquaculture industries and agro-industries.

The constructed wetland system also could be used to clean polluted rivers and other water bodies. This derived technology can eventually be used to rehabilitate grossly polluted rivers in the country. The constructed wetland treatment system is widely applied for various functions. These functions include primary settled and secondary treated sewage treatment, tertiary effluent polishing and disinfecting, urban and rural runoff management, toxicant management, landfill and mining leachate treatment, sludge management, industrial effluent treatment, enhancement of instream nutrient assimilation, nutrient removal via biomass production and export, and groundwater recharge.

The primary purpose of constructed wetland treatment systems is to treat various kinds of wastewater (municipal, industrial, agricultural and storm water). However the system usually serves other purposes as well. A wetland can serve as a wildlife sanctuary and provide a habitat for wetland animals. The wetland system can also be aesthetically pleasing and serve as an attractive destination for tourists and local urban dwellers. It can also serve as a public attraction sanctuary for visitors to explore its environmental and educational possibilities. It appeals to different groups varying from engineers to those involved in wastewater facilities as well as environmentalists and people concerned with recreation. This constructed wetland treatment system also provides a research and training ground for young scientists in this new research and education arena. Constructed wetlands, in contrast to natural wetlands, are man-made systems or engineered wetlands that are designed, built and operated to emulate functions of natural wetlands for human desires and needs

METHODOLOGY TO PREPARE VARIOUS TYPES OF CONSTRUCTED WETLAND
Constructed wetland systems are classified into two general types: the Horizontal Flow System (HFS) and the Vertical Flow System (VFS). HFS has two general types: Surface Flow (SF) and Sub-surface Flow (SSF) systems. It is called HFS because wastewater is fed at the inlet and flows horizontally through the bed to the outlet. VFS are fed intermittently and drains vertically through the bed via a network of drainage pipes. Surface Flow (SF) - The use of SF systems is extensive in North America. These systems are used mainly for municipal wastewater treatment with large wastewater flows for nutrient polishing. The SF system tends to be rather large in size with only a few smaller systems in use. The majority of constructed wetland treatment systems are Surface-Flow or Free-Water surface (SF) systems. These types utilise influent waters that flow across a basin or a channel that supports a variety of vegetation, and water is visible at a relatively shallow depth above the surface of the substrate materials. Substrates are generally native soils and clay or impervious geotechnical materials that prevent seepage (Reed, et al., 1995). Inlet devices are installed to maximize sheet flow of wastewater through the wetland, to the outflow channel. Typically, bed depth is about 0.4 m.
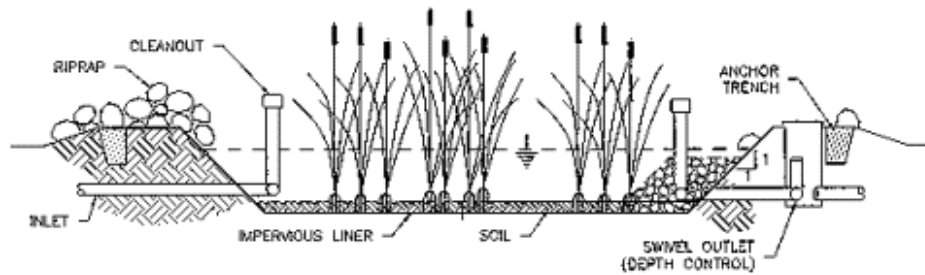
Figure 1: Surface Flow Constructed Wetland

Sub-surface Flow (SSF) system - The SSF system includes soil based technology which is predominantly used in Northern Europe and the vegetated gravel beds are found in Europe, Australia, and South Africa and almost all over the world. The substrate will support the growth of rooted emergent vegetation of Phragmite karka or Reed grass. It is also called "Root-Zone Method" or "Rock-Reed-Filter" or "Emergent Vegetation Bed System".
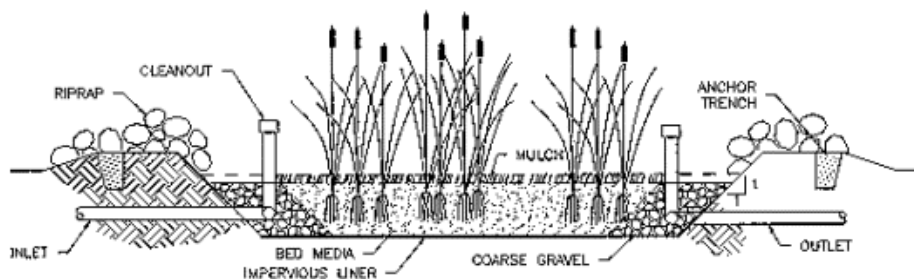

Figure 2: Typical configuration of a sub-surface flow Constructed wetland

METHODOLOGY OF CONSTRUCTED WETLAND TREATMENT SYSTEMS FOR WASTE WATER TREATMENT

The creation of a constructed wetland treatment system can be divided into a wetland construction and vegetation establishment stage. Wetland construction includes pre-construction activities such as land clearing and site preparation, followed by construction of a wetland landform and installation of water control structures. In the stage of site clearing and grubbing, the site is cleared and existing vegetation is removed to allow construction of wetland cells. All tree root stumps and rubble below ground should be removed. Some endemic species with conservation values should be transferred off site for ex-conservation or protected intact on the site. For landforming, tractors are used to remove and stockpile topsoils from the created wetland to be reused. General contours of the wetland are graded, followed by the construction of wetland cell berms by compacting soil and installing of liners. Deep zones and islands will be created. Final site grading consists of leveling the wetland cell bottom to optimise the spreading and sheetflow 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 WETLANDS PLANTS IN WASTEWATER TREATMENT

In general, the most significant functions of wetland plants (emergent) in relation to water purification are the physical effects brought by the presence of the plants. The plants provide a huge surface area for attachment and growth of microbes. The physical components of the plants

stabilise the surface of the beds, slow down the water flow thus assist in sediment settling and trapping process and finally increasing water transparency.

Wetland plants play a vital role in the removal and retention of nutrients and help in preventing the eutrophication of wetlands. A range of wetland plants has shown their ability to assist in the breakdown of wastewater. The Common Reed Phragmites karka and Cattail Typha angustifolia are good examples of marsh species that can effectively uptake nutrients.

Physical - Macrophytes stablise the surface of plant beds, provide good conditions for physical filtration, and provide a huge surface area for attached microbial growth. Growth of macrophytes reduces current velocity, allowing for sedimentation and increase in contact time between effluent and plant surface area, thus, to an increase in the removal of Nitrogen.

Soil hydraulic conductivity - Soil hydraulic conductivity is improved in an emergent plant bed system. Turnover of root mass creates macropores in a constructed wetland soil system allowing for greater percolation of water, thus increasing effluent/plant interactions.

Organic compound release - Plants have been shown to release a wide variety of organic compounds through their root systems, at rates up to 25% of the total photosynthetically fixed carbon. This carbon release may act as a source of food for denitrifying microbes (Brix, 1997). Decomposing plant biomass also provides a durable, readily available carbon source for the microbial populations.

Microbial growth - Macrophytes have above and below ground biomass to provide a large surface area for growth of microbial biofilms. These biofilms are responsible for a majority of the microbial processes in a constructed wetland system,

CONSTRUCTED WETLAND TREATMENT MECHANISMS

Wetlands have been found to be effective in treating BOD, TSS, N and P as well as for reducing metals, organic pollutants and pathogens. The principal pollutant removal mechanisms in constructed wetlands include biological processes such as microbial metabolic activity and plant uptake as well as physico-chemical processes such as sedimentation, adsorption and precipitation at the water sediment, root sediment and plant – water interfaces (Reddy and DeBusk 1987).

Following treatment are done
1. Nitrogen removal mechanisms.
2. Phosphorous removal mechanisms.
3. Removal of metals, pathogens, other pollutants.

CONCLUSION & RESULTS

Monitoring and maintenance of the wetland areas is a key issue in maintaining wetland functioning. Wetland monitoring is required to obtain sufficient data to determine the wetland performance in fulfilling the objectives. Wetland maintenance is required to manage macrophytes and desirable species, to remove invading weeds, to remove sediment from the wetlands, and to remove litter from the wetlands Effective wetland performance depends on adequate pretreatment, conservative constituent and Nutrient removal depends upon seasons; hence it depends upon the temperature. The nutrient removal was higher in growing season rather than colder months. Planted microcosm outperformed unplanted microcosms, which proves the importance of macrophysics in a wetland. These plants help in nutrient cycling and microbial processes, which are major processes involved in nutrient removal. The average reduction of nitrate and nitrite concentration in the first year was 35.6 % and 49.2% in the flowing year. The significant difference

in the net reductions was due to increase in plant cover, which helped in increasing HRT of the wetland and with increase in time, accumulation of the organic material.

Increase the rate of denitrification. Total phosphorus (TP) reduction for the first year was 74.4% and the reduction decreased in the second water year to 40.6% for an overall reduction of 59.2%.The average overall reduction of SRP (soluble reactive phosphorus) was 54.4% and 59.4% in the first and the second year respectively.

REFERENCES

1. Andersson,J.L, Bastviken, S.K., and Tonderski, K.S. 2005. Free water surface wetlands for wastewater treatment in Sweden: nitrogen and phosphorus removal. Water science and technology. 51(9), 31- 46
2. Bastviken, S. 2006. Nitrogen removal in treatment wetlands –Factors influencing spatial and temporal variations. Dissertation No 1041. Linköping University, Sweden Davis, L. 1993. A handbook for constructed wetlands. Available at http://www.epa.gov/owow/wetlands/pdf/hand.pdf
3. DeBusk. W.F. 1999. Wastewater Treatment Wetlands: Applications and Treatment Efficiency. Available at: http://edis.ifas.ufl.edu/SS294
4. Fink, D.F., W.J.Mitsch. 2004. Seasonal and storm event nutrient removal by a created wetland in an agricultural watershed. Ecological Engineering, 23(4-5); 313-325
5. Fisher, J. and Acreman, M.C. 2004. Wetland nutrient removal: a review of the evidence. Hydrology and earth systems sciences. 8(4), 673-685
6. Maine, M.A., N. Sune, H.Hadad, G. Sanchez, C. Benetto. 2006. Nutrient and metal removal in a constructed wetland for wastewater treatment from a metallurgic industry. Ecological Engineering. 26(4); 341-347
7. Picard, C.R, Fraser, L.H. and Steer, D. 2005. The interacting effects of temperature and plant community type on nutrient removal in wetland microcosms. Bioresource technology. 96(9), 1039 – 1047
8. Sakadevan, K., H.J. Bavor.1999. Nutrient removal mechanisms in constructed wetlands and sustainable Water management. Water Science and Technology. 40(2); 121-128
9. Sundaravadivel, M. and Vigneswaran,S. 2001. Constructed Wetlands for Wastewater treatment. Critical Reviews in Environmental Science and Technology, 31(4):351–409
10. USEPA. 2006. Unites states environmental protection agency. Available at: http://www.epa.gov/wetlands/
11. Verhoeven, J.T. and Meuleman, F.M. 1999. Wetlands for wastewater treatment: Opportunities and Limitations. Ecological engineering. 12, 5-12
12. Constructed wetlands 2002. Alternative Systems Plan Review and Design Course Available at:http://www.cet.nau.edu/Projects/WDP/resources/treatmentsyst/Wetland.htm
13. Magmedov, V. 2002. Constructed wetlands for low cost treatment. . Available at http://www.constructedwetlands.org/cw/index.cfm
14. Nitrogen cycles project. Illinois State Water Survey. Available at: http://www.sws.uiuc.edu/nitro/biogeo.asp