Bioscene

Volume- 21 Number- 01

ISSN: 1539-2422 (P) 2055-1583 (O)

www.explorebioscene.com

An efficient green technology for environmental sustainability-An over view

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Abstract

This paper gives an over view on importance , maintenance and macrophytes vegetation and micro organisms in constructed wet lands. Wetlands are transitional areas between land and water. 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. Water is introduced at one end and flows over the surface or through the substrate, and is discharged at the other end through a weir or other structure which controls the depth of the water in the wetland. Similarly to natural wetlands, constructed wetlands also act as a biofilter and/or can remove a range of pollutants (such as organic matter, nutrients, pathogens, heavy metals) from the water. There are several types of constructed wetlands. surface flow wetlands, subsurface flow wetlands, and hybrid systems that incorporate surface and subsurface flow wetlands. The microbial biomass is a major sink for organic carbon and many nutrients. Macrophytes play an important role in nutrient recycling,stabilizes the surface of beds, provides good conditions for physical filtration, provides huge surface area for attached microbial growth and habitat for wild life. They mediate transfer of oxygen to the rhizosphere by leakage from roots leads to aerobic degradation of organic mailer and nitrification. Constructed wetland systems should be designed and built to blend into the home's landscaping. The best way to achieve this goal is to determine where the onsite wastewater treatment system will be located before the house is built. Effective planning before building the house simplifies the system.

Key words: 1. Constructed wet lands (CWs), 2.Types, 3.Microorganisms, 4.Macrophytes, 5.Onsite waste water treatment, 6.Sustainable green technology.

Introduction:

Wetlands are transitional areas between land and water. The boundaries between wetlands and uplands or deep water are therefore not always distinct. The term "wetlands" encompasses a broad range of wet environments, including marshes, bogs, swamps, wet meadows, tidal wetlands, floodplains, and ribbon (riparian) wetlands along stream channels.

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. Water is introduced at one end and flows over the surface or through the substrate, and is discharged at the other end through a weir or other structure which controls the depth of the water in the wetland.

The removal efficiencies of the CW for Pb, Cd, Fe, Ni, Cr, and Cu were 50%, 91.9%, 74.1%, 40.9%, 89%, and 48.3%, respectively. Furthermore, the performance of the CW was efficient enough to remove the heavy metals, particularly Cd, Fe, and Cu, from the industrial wastewater fed to it[1]. Comparative evaluation of three different plants species, i.e. *Canna indica* L., *Typha angustifolia* L. and *Cyperus alternifolius* L. planted vertical constructed wetlands (CWs) microcosms for Cu, Cr, Co, Ni and Zn removal from aqueous solution. Results demonstrate that the wetland bed depth has significant, direct effect on final heavy metal removal efficiencies. Considering three different plant species, Zn removal was found to be highest (99.3% in *T. angustifolia*planted CWs in 72 h of treatment time), and Co removal was found to be lowest (54.6% in *T. angustifolia* planted CW in 72 h of treatment time).[2]

Constructed wetlands are engineered systems that use natural functions vegetation, soil, and organisms to treat wastewater. Depending on the type of wastewater the design of the constructed wetland has to be adjusted accordingly. Constructed wetlands have been used to treat both centralized and on-site wastewater. Primary treatment is recommended when there is a large amount of suspended solids or soluble organic matter (measured as BOD and COD)[3].

Similarly to natural wetlands, constructed wetlands also act as a biofilter and/or can remove a range of pollutants (such as organic matter, nutrients, pathogens, heavy metals) from the water. Constructed wetlands are a sanitation technology that have not been designed specifically for pathogen removal, but instead, have been designed to remove other water quality constituents such as suspended solids, organic matter and nutrients (nitrogen and phosphorus)[3]. All types of pathogens (i.e., bacteria, viruses, protozoan and helminths) are expected to be removed to some extent in a constructed wetland. Subsurface wetland provide greater pathogen removal than surface wetlands[3]. The planted vegetation plays an important role in contaminant removal. The filter bed, consisting usually of sand and gravel, has an equally important role to play[4]. Some constructed wetlands may also serve as a habitat for native and migratory wildlife, although that is not their main purpose.

There are several types of constructed wetlands. Surface flow wetlands, subsurface flow wetlands, and hybrid systems that incorporate surface and subsurface flow wetlands. Constructed wetland systems can also be combined with conventional treatment technologies.

Surface flow wet lands: A surface flow (SF) wetland consists of a shallow basin, soil or other medium to support the roots of vegetation, and a water control structure that maintains a shallow depth of water. The water surface is above the substrate. SF wetlands look much like natural marshes and can provide wildlife habitat and aesthetic benefits as well as water treatment. In SF wetlands, the near surface layer is aerobic while the deeper waters and substrate are usually anaerobic. Storm water wetlands and wetlands built to treat mine drainage and agricultural runoff are usually SF wetlands. SF wetlands are sometimes called free water surface wetlands or, if they are for mine drainage, aerobic wetlands. The advantages of SF wetlands are that their capital and operating costs are low, and that their construction, operation, and maintenance are straightforward. The main disadvantage of SF systems is that they generally require a larger land area than other systems.

Subsurface 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. 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. SSF wetlands have most frequently been used to reduce 5-day biochemical oxygen demand (BOD5) from domestic wastewaters. The advantages cited for SSF wetlands are greater cold tolerance, minimization of pest and odor problems and possibly greater assimilation potential per unit of land area than in SF systems. It has been claimed that the porous medium provides greater surface area for treatment contact than is found in SF wetlands, so that the treatment responses should be faster for SSF wetlands which can, therefore, be smaller than a SF system designed for the same volume of wastewater. Since the water surface is not exposed, public access problems are minimal. Several SSF systems are operating in parks. with public access encouraged. The disadvantages of SSF wetlands are that they are more expensive to construct, on a unit basis. than SF wetlands. Because of cost, SSF wetlands are often used for small flows. SSF wetlands may be more difficult to regulate than SF wetlands, and maintenance and repair costs are generally higher than for SF wetlands. A number of systems have had problems with clogging and unintended surface flows.

Hybrid systems: Single stage systems require that all of the removal processes occur in the same space. In hybrid or multistage systems, different cells are designed for different types of reactions. Effective wetland treatment of mine drainage may require a sequence of different wetland cells to promote aerobic and anaerobic reactions. as may the remoral of ammonia from agricultural wastewater.

Macrophytes play an important role in nutrient recycling, stabilizes the surface of beds, provides good conditions for physical filtration, provides huge surface area for attached microbial growth and habitat for wild life. Macrophytes mediated transfer of oxygen to the rhizosphere by leakage from roots leads to aerobic degradation of organic mailer and nitrification.

Life forms of aquatic macrophytes [5]:

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

(ii) **Floating-leaved aquatic macrophytes**: These includes both species which are rooted in the substrate, e.g. Nymphaea spp. and Nuphar spp. (Waterlilies), Potamogeton natans

a.) **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 in the substrate, e.g. Nymphaea spp. and Nuphar spp. (Waterlilies), Potamogeton natans (Pondweed), and Hydrocotyle vulgaris (Pennyworth), and species which are freely floating on the water surface, e.g. Eichhornia crassipes (Water Hyacinth), Pistia (e.g. Lemnaceae, Azolla, Salvinia).

b.) Floating-leaved aquatic macrophytes: These includes both species which a in the substrate, e.g. Nymphaea spp. and Nuphar spp. (Waterlilies), Potamogeto (Pondweed), and Hydrocotyle vulgaris (Pennyworth), and species which a floating on the water surface, e.g. Eichhornia crassipes (Water Hyacinth stratiotes (Water Lettuce) and Lemna spp. and Spirodella spp. (Duckweed). T floating species are highly diverse in form and habit, ranging from large pl rosettes of aerial and/or floating leaves and well-developed submerged ro Eichhornia, Trapa, Hydrocharis), to minute surface-floating plants with few or (e.g. Lemnaceae, Azolla, Salvinia).

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

The microbial biomass is a major sink for organic carbon and many nutrients. Dissolved biodegradable material is removed from the wastewater by decomposing microorganisms which are living on the exposed surfaces of the aquatic plants and soils. Decomposers such as bacteria, fungi, and actinomycetes are active in any wetland by breaking down this dissolved and particulate organic material to carbon dioxide and water. This active decomposition in the wetland produces final effluents with a characteristic low dissolved oxygen level with low pH in the water. The effluent from a constructed wetland usually has a low BOD as a result of this high level of decomposition. Aquatic plants play an important part in supporting these removal processes. Certain aquatic plants pump atmospheric oxygen into their submerged stems, roots, and tubers. Oxygen is then utilized by the microbial decomposers attached to the aquatic plants below the level of the water. Plants also play an active role in taking up nitrogen, phosphorus, and other compounds from the wastewater. This active incorporation of nitrogen and phosphorus can be one mechanism for nutrient removal in a wetland. Some of the nitrogen and phosphorus is released back into the water as the plants die and decompose. In the case of nitrogen much of the nitrate nitrogen can be converted to nitrogen gas through denitrification processes in the wetland.

Macrophytes have several intrinsic properties that makes them an indispensable component of constructed wetlands. The most important functions of the macrophytes in relation to the treatment of wastewater are the physical effects brought about by the presence of the plants. The macrophytes stabilise the surface of the beds, provide good conditions for physical filtration, prevent vertical flow systems from clogging, insulate against frost during winter, and provide a huge surface area for attached microbial growth. Contrary to earlier belief, the growth of macrophytes does not increase the hydraulic conductivity of the substrate in soil-based subsurface flow constructed wetlands. The metabolism of the macrophytes affects the treatment processes to different extents depending on the design of the constructed wetland. Plant uptake of nutrients is only of quantitative importance in low-loaded systems (surface flow systems). Macrophyte-mediated transfer of oxygen to the rhizosphere by leakage from roots increases aerobic degradation of organic matter and nitrification. The macrophytes have additional site-specific values by providing habitat for wildlife and making wastewater treatment systems aesthetically pleasing.[6]

Constructed wetland containing tolerant aquatic macrophytes have been found to remove contaminants from domestic wastewater more efficiently. Vertical Flow Constructed wetland was applied and examined for the removal efficiency of organic and inorganic pollutants from domestic wastewater, by using gravel and sand as substrates planted with *Typha augustifolia* and other without plantation which serves as a control. To evaluate the performance, three different operating Hydraulic Retention Time (HRT) 12, 24 and 36 hours were maintained. The treatment efficiency was found to be maximum in cattail planted VFCW with 36 hours HRT followed by 24 and 12 hours. The removal efficiency at 36 hours HRT were found to be 84.66% for TDS, 92.90% for Turbidity, 80.53% for COD, 75.49% for BOD5, 83.51% for PO4 [7]

For treating domestic wastewater generated by small communities *Phragmites* sp. would be more efficient rather than *Typha* sp. [8]

Small towns and rural areas often have problems meeting todays strict water quality standards. Many lack central wastewater treatment systems. Constructed wetlands can now provide them with a good wastewater treatment alternative. Smaller versions can also be built to meet the needs of homes with failed septic systems. Constructed wetlands can help us improve water quality as we learn more and apply them effectively to treat various types of wastewater.

Constructed wetland systems should be designed and built to blend into the home's landscaping. The best way to achieve this goal is to determine where the onsite wastewater treatment system will be located before the house is built. Effective planning before building the house simplifies the system.

In developing countries, the wise use of natural and artificial wetlands for water purification is particularly valuable and exploitable for the protection of water quality in catchments, rivers and lakes. Constructed wetlands are potentially good, low-cost, appropriate technological treatment systems for domestic wastewater in rural areas. Better still, they can be integrated into agricultural and fish production systems where the products are useable and/or re-cycled for optimal efficiency. However, currently, constructed wetlands are rarely installed. The reasons for this are discussed drawing attention to the limitations of aid programmes from donor countries and the need for in-house research, training and development. Recommendations for the development and wider use of constructed wetlands in developing countries are made [9].

Wetland can effectively remove or convert large quantities of pollutants from point sources (municipal, industrial and agricultural wastewater) and non-point sources (mines, agriculture and urban runoff), including organic matter, suspended solids, metals and nutrients. The focus on wastewater treatment by constructed wetlands is to optimise the contact of microbial species with substrate, the final objective being the bioconversion to carbon dioxide, biomass and water.

Contaminants removal process in sub surface flow constructed wet lands (SSFCW) is very important and the process is given [10].

1. **Biological processes:** There are six major biological reactions involved in the performance of constructed wetlands, including photosynthesis, respiration, fermentation, nitrification, denitrification and microbial phosphorus removal (Mitchell, 1996b). Photosynthesis is performed by wetland plants and algae, with the process adding carbon and oxygen to the wetland. Both carbon and oxygen drive the nitrification process. Plants transfer oxygen to their roots, where it passes to the root zones (rhizosphere). Respiration is the oxidation of organic carbon, and is performed by all living organisms, leading to the formation of carbon dioxide and water. The common microorganisms in the CW are bacteria, fungi, algae and protozoa. The maintenance of optimal conditions in the system is required for the proper functioning of wetland organisms. Fermentation is the decomposition of organic carbon in the absence of oxygen, producing energy-rich compounds (e.g., methane, alcohol, volatile fatty acids). This process is often undertaken by microbial activity. Nitrogen removal by nitrification/denitrification is the process mediated by microorganisms. The physical process of volatilization also is important in nitrogen removal. Plants take up the dissolved nutrients and other pollutants from the water, using them to produce additional plant biomass. The nutrients and pollutants then move through the plant body to underground storage organs when the plants senesce, being deposited in the bottom sediments through litter and peat accretion when the plants die. Wetland microorganisms, including bacteria and fungi, remove soluble organic matter, coagulate colloidal material, stabilize organic matter, and convert organic matter into various gases and new cell tissue (Mitchell, 1996a). Many of the microorganisms are the same as those occurring in conventional wastewater treatment systems. Different types of organisms, however, have specific tolerances and requirements for dissolved oxygen, temperature ranges and nutrients.

2. **Chemical processes:** Metals can precipitate from the water column as insoluble compounds. Exposure to light and atmospheric gases can break down organic pesticides, or kill diseaseproducing organisms (EPA, 1995). The pH of water and soils in wetlands exerts a strong influence on the direction of many reactions and processes, including biological transformation, partitioning of ionized and un-ionised forms of acids and bases, cation exchange, solid and gases solubility.

3. **Physical processes:** Sedimentation and filtration are the main physical processes leading to the removal of wastewater pollutants. The effectiveness of all processes (biological, chemical, physical) varies with the water residence time (i.e., the length of time the water stays in the wetland). Longer retention times accelerate the remove of more contaminants, although too-long retention times can have detrimental effects.

Constructed wetlands are gaining recognition as a management practice for use in irrigated agriculture to reduce bacterial loads and a wide variety of water quality contaminants in agricultural return flows prior to discharge into waterways [11].

Pollutants in agricultural irrigation return flow (tail water) constitute a significant nonpoint source of pollution in intensive agricultural regions such as the Central Valley of California. Constructed wetlands (CWs) represent a feasible mitigation option to remove pollutants including pesticides in the tailwater and CWs were found to be highly effective in reducing pyrethroid concentrations in the tailwater, with season-average concentration reductions ranging from 52 to 94% [12].

Constructed Wetlands are an effective, environmentally friendly means of treating liquid and solid waste. CWs could bring major economic benefits to developing countries through the provision of biomass and aquaculture. Such wetland systems can yield a significant profit for local communities, and might be a powerful tool for breaking the poverty cycle. CWs are effective at reducing loads of BOD/COD, nitrogen, phosphorus and suspended solids by up to 98%. However, despite the suitability of climate in developing countries, the spread of wetlands in such areas has been "depressingly slow" [13].

Conclusions:

By following efficient and effective on site waste water treatment systems constructed wet lands number will be increased as they are very useful for environmental sustainability. The potential use of constructed wet lands as green technology for waste water treatment, will benefit the biodiversity from adverse effects of water pollution. The lack of standard information for engineers is currently limiting the design and construction of effective low cost systems. Constructed wetlands may not effectively treat some types of complex pollutants. These systems also need more land than conventional systems. High land costs and lack of suitable land can make construction of large systems impractical. Sites which are relatively flat have deep soils, and a low groundwater water table is needed for small scale stems. Mosquito can also be a problem, but this can be prevented or controlled with proper system design and management.

Constructed Wetlands have been characterized as an environmentally friendly, sustainable technology which provides multiple economic, ecological, technical and societal benefits. It is a rising technology which can be effectively used for domestic, municipal and industrial wastewater treatment, as also for sludge dewatering and drying [15].

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