International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249 – 8958, Volume-2, Issue-1, October 2012

Water Recycling and Reuse by Using Wetland

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Abstract: Scarcity of water is a challenge worldwide because of growing population and Industrialization. Billions of people have insufficient access to safe drinking water. Ground water levels are falling and all type of water bodies like river, lake and oceans are getting polluted. Many issues resulting in water scarcity could be avoided with better water management. A better option is reuse and recycles the wastewater for secondary purposes like toilet flushing, gardening, lawn and irrigation.

Wastewater has high Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and contains Total Suspended Solid (TSS), Nitrogen (N), Phosphorous (P), alkaline in nature. Conventional wastewater treatment goes through primary, secondary and tertiary treatment which is expensive to build, operate and maintain. Wastewater should be treated & reused such that treatment should be economical, natural and not affecting the environment. The best option is to provide onsite wastewater treatment by using geology of wetland for clean & hygienic villages.

Wetlands are parts of earth's surface between terrestrial and aquatic system. Wetlands are generally shallow in depth which includes water, soil and vegetation. There are two types of Wetlands like Natural and Constructed wetland. Selection of location of natural wetlands is dependent on various geological properties. In natural wetland, control on process is difficult but in constructed wetland, we can control the process of treatment.

Constructed Wetland is an artificial wastewater treatment, consisting of shallow ponds (<1 meter depth). Water Hyacinth (Eichronia crassipes) is available locally It is large, bulbous floating plants with extensive root system, perennial aquatic plant with rounded, upright, shiny green leaves and spikes of lavender flower. It is good in nutrient removal from wastewater through the harvesting, prevents the growth of algae and maintaining pH value . The root zones of plants develop into a diverse ecology which includes bacteria, fungi, predators and filter feeders for creating aerobic conditions. Constructed wetlands provide habitat for wildlife and helps to improve aesthetic value.

I. INTRODUCTION

Mankind has been exploiting the natural resources since the beginning of civilization to ensure his comfort. Water is one of the important resources which are the essential commodities of society. Water is precious and therefore WHO refers to "all people, whatever their stage of development and their social and economic conditions, have right to have access to an adequate supply of safe drinking water" as one of primary objectives of environmental sanitation. The stress on water usage, sanitation and wastewater disposal has increased due to increase in population. The per capita water availability is also decreasing with time. The industrial revolution of the eighteenth century was considered as boon to the economy as well as basic foot step towards the development. It changed the basic lifestyle of human being which brought the countries of world together. The same boon has now proved to be a "boomerang" as pollution caused by the industrialization. Pollution of air, water and land has put our planet earth in a danger.

About 75-80% of the surface area of the earth is covered with water in the form of sea but sea water is unfit for any domestic and industrial purpose. Moreover, it requires very expensive treatment to make it fit for any domestic as well as industrial use. Even though water is considered renewable resource, the over exploitation of ground water and contamination of surface water resources and ground resources have forced us to consider it as non renewable resource. The demand of water is increased due to increase in population and industrialization and therefore in future scarcity of water is a challenge worldwide. Many issues that causes water scarcity could be avoided with better water management practices.

In water management practices the best option is to reuse and recycle the wastewater. Water recycling is reusing treated wastewater for non potable purpose such as toilet flushing, floor cleaning, gardening, car washing and construction. Water recycling can help us find ways to decrease the diversion of water from sensitive ecosystem and to decrease wastewater discharge to sensitive water bodies and to reduce and prevent pollution

In rural areas, small communities or in isolated institutional complex the use of conventional method (small sewage treatment facilities) in centralized system implies a high cost of construction, maintenance and transport, which is unaffordable. Then, the wastewater treatment is usually carried out by septic tank system which occasionally have been proven inadequate for wastewater treatment and suspected to be a major cause of water pollution. These systems are many times ineffective due to shallow soils or poor soil percolation rates and high ground water table leading to inefficient treatments, which further contributes to pollution of surface water and groundwater. To overcome this problem the application of natural system for wastewater in small communities and rural areas is another possible option to be in mind. Natural processes have always cleansed water as it flowed through rivers, lakes, streams, and wetlands. In the last several decades, systems have been constructed to use some of these processes for water quality improvement. As a result of the exponentially increasing demands of human expansion and resource exploitation, it has been recognized that natural wetland ecosystems cannot always function efficiently for

Manuscript received October 01, 2011.
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desired objectives and stringent water quality standards. These and many other factors have led to the rapid development of "constructed wetlands" for wastewater treatment

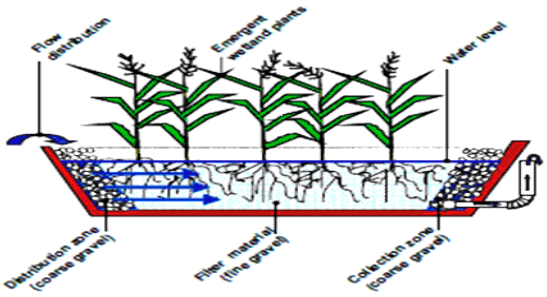
Constructed wetlands are now used to improve the quality of point and nonpoint sources of water pollution, including storm water runoff, domestic wastewater, agricultural wastewater, and coal mine drainage. Constructed wetlands are also being used to treat petroleum refinery wastes, compost and landfill leachates, fish pond discharges, and pretreated industrial wastewaters, such as those from pulp and paper mills, textile mills, and seafood processing. For some wastewaters, constructed wetlands are the sole treatment; for others, they are one component in a sequence of treatment processes. One of the most common applications of constructed wetlands has been the treatment of primary or secondary domestic sewage effluent. The treatment of wastewater by constructed wetlands can be a low-cost, low energy process requiring minimal operational attention. Constructed wetland technologies are soil based and aquatic systems, in which the major contribution made by the natural environmental components such as soil, vegetation and micro-organisms etc. Wetland systems are well suited for small communities and rural areas because of low flows of wastewater and availability of land. Natural treatment system avoids use of energy, materials and chemicals which requires very low cost for operation and maintenance. The treated effluent from this system can be reused for non-potable purpose like toilet flushing, gardening and irrigation.In order to meet the water needs, the wastewater from various sources are treated and reused. One such onsite method of wastewater treatment is constructed wetland. Wastewater contains nutrients (nitrogen and phosphorous), solids (organic and inorganic), chemicals (from cleaners, disinfectants, and medications), Pathogens (disease causing organisms) and water. Constructed Wetlands provide water quality improvement, flood storage and the desynchronization of storm, rainfall and surface runoff, cycling of nutrients and other materials, habitat for fish and wildlife, passive recreation, such as bird watching and photography, active recreation, such as hunting, education and research, aesthetics and landscape enhancement.

II. ONSTRUCTED WETLANDS

Constructed wetlands can be defined as a wetland specifically constructed for the purpose of wastewater treatment at a selected site. Constructed wetlands have been used for (i) treating septic tank and Imhoff tank effluents from housing complexes and (ii) providing tertiary treatment to effluents from aerated lagoons and conventional sewage treatment plants.

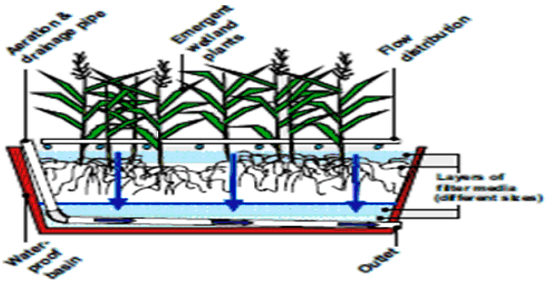
A. Types of Wetlands

Constructed wetlands (also called ‘reed beds’ and ‘root zone treatment’) are generally of two types as far as their water surface is concerned. The two most popular CWS design types for individual sewage treatment are the surface flow (SF), also called free-water system, and the subsurface flow (SSF) system. Both of these are horizontal flow systems where wastewater enters at one end of a lined excavation and exits from the other end.



Surface Flow Wetland

The SF system is usually a basin or channel surrounded by a barrier of ponded wastewater and soil to support the growth of rooted emergent vegetation. The open-water wetland has a small layer of sand to root the plants. SF wetlands are better suited for large community systems in milder climates for several reasons. The system can be fenced to prevent public contact, mosquito habitat is not a major issue, freezing is unlikely, and the amount of gravel is minimal, therefore lowering cost.



Subsurface Flow Wetland

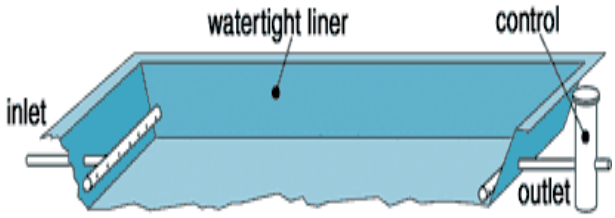
In the SSF system, the water level is maintained below the surface of the gravel substrate by a stand-pipe structure at the discharge end of the cell which minimizes the risk of exposure to people and animals and greatly reduces mosquito breeding. The SSF is the most common constructed wetland system used for small flows (less than 10,000 gallons per day) and is often used for individual homes, small clusters of houses, or resorts.

B. Working of wetlands

Solids are removed by physical filtration and settling within the gravel/root hair matrix. Organic matter may also be removed by these physical processes, but is ultimately removed through biodegradation. Biological treatment may be anaerobic (as in a septic tank where very little or no oxygen is present in the wastewater); or aerobic, with oxygen supplied by both diffusion from the atmosphere at the surface of the beds (much lower in SSF than SF systems) and by "leaking" of oxygen from the roots of cattails, bulrushes, reeds, and other emergent aquatic plants.

Constructed wetlands have four parts: the liner,

distribution media, plants, and under drain system. he liner keeps the wastewater in and groundwater out of the system. Although the liner can be made from a number of materials, 30 mil polyvinyl chloride (PVC) is the most common and the most reliable Clay liners are not recommended because they can crack if too thin, allowing untreated wastewater to move into the soil and contaminate groundwater.



c/s of wetland

Plants growing in the cell are often cattails, but other species include bulrushes, reeds, and sedges. Flora must grow and flourish in the system for it to operate at maximum efficiency.

The under-drain system at the end of the wetland is a slotted 4-inch pipe covered with drain field rock. The under-drain moves the treated effluent out of the wetland and keeps the effluent level below the surface of the gravel. This prevents the effluent from coming into contact with people and keeps mosquitoes from breeding in the wetland. It also keeps the water level high enough to sustain plant growth.

C. Advantages of Wetlands

Wetlands are a cost-effective and technically feasible approach to treating waste-water and runoff for several reasons:

1. Wetlands can be less expensive to build than other treatment options.
2. Operation and maintenance expenses (energy and supplies) are low.
3. Operation and maintenance require only periodic, rather than continuous, on-site labor.
4. They facilitate water reuse and recycling.

In addition:

5. They can be excavated in land having impervious strata to fit harmoniously into the landscape.
6. They provide numerous benefits in addition to water quality improvement, such as wildlife habitat and the aesthetic enhancement of open spaces.
7. They are an environmentally-sensitive approach that is viewed with favor by the general public.

D. Limitations of Wetlands

There are limitations associated with the use of wetlands:

8. They generally require larger land areas than do conventional wastewater treatment systems.
9. Wetland treatment may be economical relative to other options only where land is available and affordable.
10. The biological components are sensitive to toxic chemicals, such as ammonia and pesticides.

III. CASE STUDY OF DEPT. OF TECHNOLOGY BUILDING

Rajaram Lake is used by Shivaji University, Kolhapur for supply of water to the Hostels, administrative buildings and departments for use other than drinking. The University Technology building has come newly near the lake. The Technology Department has B.Tech and M.Tech courses with 5 different specializations and about 1200 students, faculty and staff. The wastewater discharged from the Department is likely to mix with Rajaram lake water. This will change Physico-chemical characteristics of lake water which is supplied to University. This release may also lead to eutrophication in future.Presently the effluent is treated anaerobically in the septic tank but effluent still contains harmful pollutants and nutrients like Phosphor and Nitrogen. Therefore, there is need of tertiary treatment which works naturally. Constructed wetland is built near Technology Department in which all wastewater from septic tank is collected and treated with water hyacinth, E.Crassipes. The wastewater is exposed to atmosphere. Water hyacinth is used for the study which grows rapidly and provides enough shade which prevents the growth of algae. The continuous process is kept under observation .The daily inlet and outlet physico-chemical parameters were analyzed. Wastewater parameters studied are Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Suspended Solids (SS), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, Nitrogen and Phosphorus

A. Characteristics of wastewater at institutional complex

Institutional complex mainly consists administrative building, college building, hostel building with canteen and mess building etc. The wastewater is mainly comprised of water (99.9%) together with relatively small concentration of suspended and dissolved organic and non organic solids.

I: Wastewater Characteristics

Sr. No.	Parameter	Range *
1.	pH	6.4-8.1
2.	Suspended solids	40-340
3.	Dissolved solids	80-850
4.	BOD	45-300
5.	Nitrogen	20-85
6.	Phosphorous	6-20
7.	COD	100-500
8.	Dissolved oxygen	0-1

**All parameters are in mg/liter except Ph*

It is observed that the WS system enhanced water quality using combination of physical, chemical and biological mechanisms. In physical removal mechanism suspended solids removed by sedimentation. The roots of plant

reduces velocity of wastewater and due to reduced velocity, the sediments are trapped in root. The aerobic activity gets oxygen from surface of bed and plant roots. In addition to the physical and biological mechanism, chemical removal mechanism like sorption takes place by exchanging of ions.

II: An overview of pollutant removal mechanisms

Pollutant	Removal Processes
Organic Material (Measured as BOD)	Biological Degradation, Sedimentation, Microbial uptake
Organic Contaminants (e.g. Pesticides)	Adsorption , volatilization, photolysis and biotic/ abiotic degradation
Suspended Solids	Sedimentation, Filtration
Nitrogen	Sedimentation, nitrification/denitrification, volatilization, Microbial uptake
Phosphorous	Sedimentation, Filtration, Adsorption , plant and microbial uptake
Pathogens	Natural die-off, Sedimentation, Filtration Adsorption, predation, UV degradation.
Heavy metals	Sedimentation, Adsorption, plant uptake

III: Outlet Results

Sr. No.	Parameter	Results at outlet		Standards for disposal	
		Avg. % removal	Avg. value	Into Inland surface water	On land
1	pH	Improved	7.2	5.5 - 9.0	5.5-9.0
2	DO	Improved	5.56	-	-
3	BOD	86.19 %	21.9	<30	100
4	COD	87.38 %	23.10	<250	-
5	TSS	76%	41	<100	<100
6	TDS	69.95%	119.1	<2100	<2100
7	Nitrogen	43.33%	7.92	<10	<10
8	Phosphors	45%	1.82	<5	<5

IV. CONCLUSIONS

- ✓ It is clear that the parameters like BOD, COD, TSS, TDS, N and P reduce satisfactory which proves that floating aquatic system planted with water hyacinth, *Echcornia crassipes* is more efficient in treatment of institutional wastewater.
- ✓ During the study it is observed that the wetland provides habitat to many organisms.
- ✓ No external energy as electricity is required in the operation of plant
- ✓ Potential of nutrient recovery is high.

V. SCOPE FOR FUTURE STUDY

The potential areas of further study and research are listed below ,

- ✓ Performance of Wetland by variation in the quantity of water hyacinth can be studied in future.
- ✓ Utilization of plant biomass as a fertilizer and animal feed supplement can be studied.
- ✓ Utilization of plant as a good source for production of biogas with high percentage of methane would be interesting to study.
- ✓ Utilization of plant for creating decorative items to improve aesthetic of building is a new emerging trend and due to lack of time it was not covered in this study, but can be further studied for Indian scenario.

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