Modeling and Designing of Constructed Wetland for Red/Orange Industrial Effluent

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Abstract- *In recent years, the environmental effects of industrial activities have increased considerably and current perspectives indicate that the trend for this problem is to be worsening. Degradation of water resources has become one of the most pressing global concerns currently facing mankind. The consumption of large volumes of water and the generation of organic compounds as liquid effluents are major environmental problems in Red & Orange category industry. Constructed wetlands (CWs) represent a concept to combat deterioration of water resources by acting as buffers between wastewater and receiving water bodies. This paper suggests options for adopting a constructed wetland system to treat industrial wastewaters. The primary study aims at developing a simple small-scale wetland model system to evaluate the ability of a constructed wetland system to treat different types of wastewaters. The project study is carried out to investigate feasibility and optimization in pollution concentration through Horizontal Subsurface Flow Constructed Wetland in the Red category and Orange category industry wastewater treatment using colocasia esculenta, canna indica, pampas grass(Cortaderia selloana), umbrella palm(Cyperus alternifoliu), typha augustifolia plant species. The reason is the intention to create clean technologies that can substitute the currently used "environmentally unfriendly" conventional facilities.*

Keywords- Industrial wastewater, constructed wetlands, horizontal angular subsurface flow.

I. INTRODUCTION

Water, food and energy securities are emerging as increasingly important and vital issues for India and the world. Most of the river basins in India and elsewhere are closing or closed and experiencing moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture, and industry. It diminishes the aesthetic quality of lakes and rivers. More seriously, contaminated water destroys aquatic life and reduces its reproductive ability.

Wastewater management in India has become an extremely important area of focus due to increasing Health awareness and population pressure. For instance, it is estimated that less than 20% of domestic and 60% of industrial wastewater is treated. Metros and large cities (more than 100,000 inhabitants) are treating only about 29.2% of their wastewater; smaller cities treat only 3.7% of their wastewater.

The Indian industrial sector generates an estimated 100 million tons/year of non-hazardous solid wastes, with coal ash from thermal power stations accounting for more than 70 million tons/year. Over 8 million tons/year of hazardous waste is generated in India. About 60% of these wastes, i.e., 4.8 million tons/year is estimated to be recyclable and the remaining 3.2 million tons/ year is non-recyclable.

Thousands of small scale and bigger industrial units simply dump their waste, more often toxic and hazardous, in open spaces and nearby water sources. Over the last three decades, many cases of serious and permanent damage to environment by these industries have come to the fore. As we all are well aware that almost 70% of the earth is covered by water, but only 1% of this water is pure. Despite having only 1% of pure water, we are continuously contaminating the sources of this gift. The crisis of water is increasing year by year.

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II. RESEARCH ELABORATIONS

Wastewater is any water that has been adversely affected in quality by anthropogenic influence. Wastewater can originate from a combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and from sewer inflow or infiltration. Industrial wastewater means process and non-process wastewater from manufacturing, commercial, mining, and silvicultural (forestry) facilities or activities, including the runoff and leachate from areas that receive pollutants associated with industrial or commercial storage, handling or processing, and all other wastewater not otherwise defined as domestic wastewater. Toxic waste, chemical waste, industrial solid waste and municipal solid waste are designations of industrial wastes. Sewage treatment plants can treat some industrial wastes, i.e. those consisting of conventional pollutants such as biochemical oxygen demand (BOD). Industrial wastes containing toxic pollutants require specialized treatment systems. The wastewater from industries varies so greatly in both flow and pollution strength. So, it is impossible to assign fixed values to their constituents. In general, industrial wastewaters may contain suspended, colloidal and dissolved (mineral and organic) solids. In addition, they may be either excessively acid or alkaline and may contain high or low concentrations of colored matter. These wastes may contain inert, organic or toxic materials and possibly pathogenic bacteria. Typical range of concentration values for industrial and municipal wastewater is shown in Table 1.

It may be necessary to pretreat the wastes prior to release to the municipal system or it is necessary to a fully treatment when the wastes will be discharged directly to surface or ground waters.

Domestic sewage	7	220	250	500	500	-
Dairy industry	4	12150	14000	21100	19000	320
Yeast industry	5.3	540	2100	3400	3500	9
Fruits and vegetable canning	5.5	2200	800	1400	1270	94
Textile industry	6.5	1800	840	1500	17000	155
Pulp and paper industry	8	1640	360	2300	1980	-
Beverage industry	9	760	620	1150	1290	-
Tannery industry	10	2600	2370	4950	8500	115
Fish canning	11	565	890	2350	8218	290

Table 1. Typical range of concentration values for industrial and municipal wastewater

A. Concept of constructed wetlands

The wetland as land-intensive biological treatment systems has complicated purificative mechanisms, including physio-chemistry such as substrate adsorption, substrate filtration, plant adsorption, pollutant sediment ion exchange and biochemistry such as plant sorption, microbiology oxidation, and microbiology ammunition. Besides the aesthetic aspect of macrophytes to provide wildlife habitats, the advantages of CW are relatively low cost, simple operation with stable effluent quality and good resistance to shock loading.

In recent years, these systems have been used in the purification of domestic sewage. Nowadays attention has focused particularly on the use of constructed wetlands for the treatment of industrial effluents. These natural processes of treatment include physical, chemical and biological mechanisms and require less energy, reduce the use of chemicals and have a small carbon footprint in comparison with conventional systems. In terms of contaminant removal efficiency, cost reduction and simplicity, CWs are more suitable. Among the different types of CWs, Horizontal Sub-surface Flow Constructed Wetlands (HSSFCWs) are most widely used and became low-impact alternatives to more conventional wastewater treatment processes.

III. FINDINGS

A subsurface flow (SSF) wetland consists of a sealed basin with a porous substrate of rock, gravel and soil or combination of these. The water level is designed to remain below the top of the substrate as show in Fig. 1.2

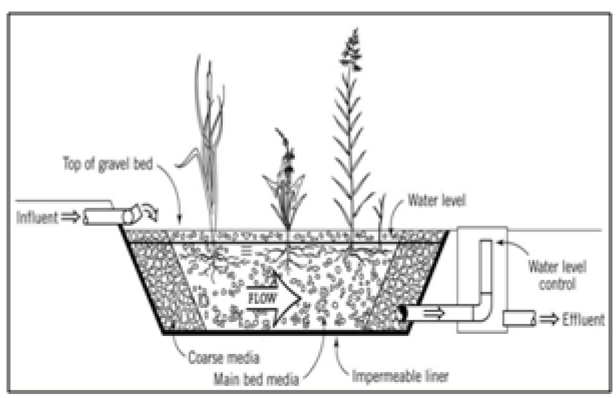

Fig. 1.2 Sub surface flow constructed wetland

A. Components of constructed wetland

1) Inlet zone- The primary criterion for design of inlet structure is discharge which should be uniform along the entire width in order to prevent short circuiting.
2) Wetland media- The system is built with slight inclination of 1-2% between inlet and outlet zones. The filter media

consist of a gravel bed underlain by an impermeable layer of filters. The bed is filled with gravel followed by a top layer of sand. The topmost layer of the wetland unit is filled with sandy clay soil to support vegetation.

3) Vegetation- The plants can be collected from a nearby lake and planted in the wetland unit. They are used to increase the residence time of water by reducing velocity so as to increase treatment time. They also add oxygen and provide a physical site for microbial bioremediation. The plants have been used to remove suspended solids, nutrients, heavy metals, toxic organic compounds and bacteria from acid mine drainage, agricultural landfill and urban storm water runoff.
4) Outlet zone- Outlet zone is designed to allow variations into level of water discharge.

The wastewater is forced vertically or horizontally into the sediments by gravity depends on the type of the system. SSF wetlands have most frequently been used to reduce biochemical oxygen demand, chemical oxygen demand, suspended solids, metals and nutrients from domestic and industrial wastewaters. These systems are very popular in Europe and South Africa. SSF CWs are further subdivided into two types: horizontal flow (HF) and vertical flow (VF), according to the flow direction of wastewater. Recently the combination of horizontal flow and vertical flow CWs has been used, named as hybrid systems, for the wastewater treatment. These hybrid systems act more efficiently to improve wastewater quality. SSF CWs are more efficient on an aerial basis as compare to SF.

IV. CONCLUSION

It is noted that CWs are now being increasingly used for environmental pollution control. Constructed wetlands were implemented in a wide range of applications, such as water quality improvement of polluted surface water bodies, wastewater on-site treatment and reuse in rural areas, campuses, recreational areas and green architectures, management of aquaculture water and wastewater, tertiary treatment, and miscellaneous applications. Water monitoring results obtained from several demonstrations show that CWs could achieve acceptable wastewater treatment performances in removing major pollutants, including suspended solids, organic matters, nutrients, and indicating microorganisms, from wastewater influent. The results indicate that if constructed wetlands are appropriately designed and operated, they could be used for secondary and tertiary industrial wastewater treatment successfully. Hence constructed wetlands can be used in the treatment train to upgrade the existing malfunctioning wastewater treatment plants, especially in developing countries. During the literature study, it was found that the wastewater parameters were best removed in planted wetland than unplanted wetland. It is because of the oxygen diffusion from roots of the plants and the nutrient uptake and insulation of the bed surface. It is also found that the increases in the detention period of the wastewater the removal rate also increases.

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