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Performance Analysis of Vertical Up-flow Constructed Wetlands for Secondary Treated Effluent

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Abstract

The use of constructed wetlands for wastewater treatment has been exercised since 1950's and still are being in use. The vertical flow constructed wetlands provide more oxygenated environment and significantly reduce the organic matter as well as microbial species from wastewater. In the present study vertical up-flow constructed wetlands were constructed and used as bio-filter to improve the water quality of secondary treated effluent. The reduction pattern is studied in this research and correlated with plant species and presence of plant. The plant species used in the constructed wetlands were *canna* and *phragmitis*. The fibrous rooting system of *canna* species causes the high aerobic conditions throughout the treatment bed which in turn facilitates higher removal in comparison to *phragmitis* planted wetland. Removal of nitrogenous compounds like ammonia-nitrogen, TKN and nitrate were observed better in *canna* planted wetlands than others.

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1. Introduction

In India, the availability of large land area is prime constraint for establishment of field scale constructed wetlands. While the subsurface vertical flow systems generally associated with about a 100 times smaller size range and 3 times smaller HRTs than the surface flow. Therefore, the vertical flow constructed seem to have an implication for better acceptability under Indian conditions [1], as it has been proven effective to treat

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different kind of wastewater worldwide including India. Till now presence of plants and their role for treatment of different type of wastewater is clear [2, 3], which increases the surface area for growth of microbes, which develops bio-film and transport oxygen upto 90 % within the system [4]. There is lack of rigorous comparative assessment of efficacy of constructed wetlands, planted with different plant species while using for tertiary treatment. Although the use of *phragmitis* and *typha* species for wetland establishment is a tradition since 1950's and still going on. *Canna indica* is commonly used plant for wetland establishment in China and other countries [5, 6] as it has rapid growth rate, large biomass and beautiful flowers with great capability of nutrient removal [7]. *Canna indica* is known as phytoremediation plant [8], had a flourishing root system with higher root growth, higher root number, larger root biomass and significantly larger root surface area than the other plant species. This plant has great tolerance to the pollutants and has long root life span [9]. To our knowledge limited information is available for use of vertical up-flow constructed wetlands for post treatment technology. The present research aim the suitability of *canna indica* for post treatment over the use of unvegetated and vegetated with *phragmitis* constructed wetland by flowing the up-flow of wastewater in favour of aesthetic appearance.

2. Material and method

Four up-flow constructed wetlands were constructed at Malaviya National Institute of Technology, Jaipur, India. Secondary treated wastewater was taken from the STP which is based on Activated Sludge Process and applied to all the wetland units. The wastewater was kept in the feeding tank and allows passing water through ports, peristaltic pump and valves to all wetland units separately. Water flows upward through the treatment bed and reaches the surface and finally the treated effluent passes out from the top most port and gets collected in the effluent collector placed underneath it. The water-flow in each of the bed is controlled using peristaltic pump and collected in inlet chamber in all units which allows uniform distribution throughout the bed. The percent removal efficiency of contaminants has been analyzed according to [10] by using inlet and outlet samples on weekly basis. Vegetation and media characteristics for each treatment unit are given as below in table1. Size and distribution of gravel in all units were same as 8-12mm gravel were placed at the top and 16-20mm gravel at the bottom.

Table 1. Different constructed wetland units with different plantation as well as media type

UFCW	Vegetation	medium
Unit1	phragmitis	gravels
Unit2	canna	gravels
Unit3	none	gravels
Unit4	canna	gravels with sand

Analysis is based on inlet and outlet sampling. A total of 20 water samples were collected on weekly basis for constructed wetland units which are planted with *canna* (with and without sand layer incorporation). The inlet samples were collected at the port located at the base of the each unit and the outflow samples were taken from the port located at the distal end. Samples were collected in autoclaved 100ml beakers and were sealed with aluminum foil. The samples were immediately transferred to the Environmental Engineering laboratory of Civil Department at MNIT Campus and analyzed within 12hrs for physicochemical analysis.

3. Result and discussion

The constructed wetlands proved efficient to reducing the many physical and chemical contaminants associated with secondary treated wastewater. The influent and effluent concentration for all constructed wetland units are shown in fig1. pH values ranges from 8.19 to 8.38 in influent and effluents of all the units. In the present research tertiary treatment is targeted and organic matter removal efficiency was evaluated in

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