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Floating Constructed Wetlandfor Improving Wastewater Treatment Efficiency of a Pond System

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1.0 INTRODUCTION AND BACKGROUND

In the realm of wastewater treatment, one of the challenges that developing countries face is implementation of low cost and low energy sewage treatment. Treatment systems with a very small energy input and low operational and maintenance cost include the pond systems. The mega city of Karachi has three wastewater treatment plants. One treatment plant is based on waste stabilization pond system technology. With continued migration of people from rural to urban areas, the treatment plants are not able to meet the targets. One solution is to construct new treatment plants but financial constraints coupled with unavailability of land forces planners and designers to come up with innovative solutions. It is here where constructed wetlands can play an important role. Constructed wetland is a low-cost green treatment technology that is a viable option to remove pollutants from a wide range of wastewaters. Floating Constructed Wetland (FCW) is an innovative variant of constructed wetland technology in which stems of the plants remain above the water surface while their roots extend into the water column beneath the floating mats [1]. The main aim of this study was to assess the potential of FCW in improving the efficiency of a pond treatment system treating domestic wastewater.

2.0 MATERIALS AND METHODS

Floating Constructed Wetland

A pond system treating wastewater at NED University campus was retrofitted with a FCW. Diamond Jumbolon (insulation sheet manufacturer) sheets made of PE material; size 1.8 m (6 feet) long, 1.2 m (4 feet wide) and 50 mm thick were used. Holes were marked and carved in conical shape and filled with sand and fertilizer to support emergent macrophytes. Later on plants were placed in the carved holes filled with supporting media. Three different plant species were planted; Typha, Canna (Red, Green, Yellow and Green) and Cypreus Papyrus.

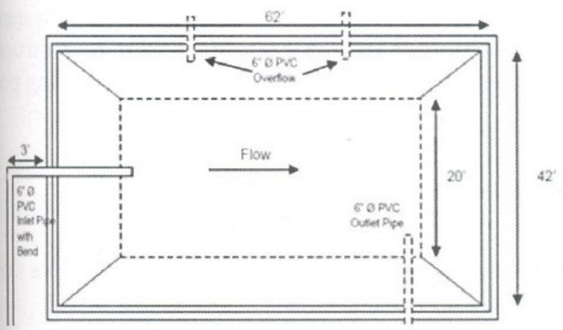

Figure 1a Plan view of pond system retrofitted with floating constructed wetland (FCW); 1b Established plants in FCW

Water Quality Improvements

For analysis of water quality improvements, grab samples were collected from the inlet and outlet of the pond system with FCW from February 2017to August 2017. Wastewater samples were tested for various physical, chemical and biological parameters using American Public Health Association standards methods [2].

3.0 RESULTS AND DISCUSSION

Establishment of Floating Constructed Wetland

The total surface area of the pond system is 242 m^2 (2604 ft^2) as shown in Figure 1a. Approximately 24% of the pond surface area was covered with FCW. All plants reached their full height within two months period. Canna plants have also blossomed with colorful flowers within four months of their introduction into the pond system. The FCW has also improved the aesthetic quality as can be seen in Figure 1b. After five months of their placement in the pond system, all plant roots extended in the range of 9 inches to 15 inches into the wastewater.

Water Quality Improvements

Table 1 represents the water quality improvements provided by the FCW treating domestic wastewater. The addition of FCW improved TSS removal by 34 % and the effluent concentration after installation of FCW was 25 mg/L. DO was also increased from 4.5 mg/L to 5.5 mg/L, indicating a 35% increase with introduction of FCW. Emergent plants transfer oxygen from plant leaf to the roots [3] and this is the possible reason for increased DO concentrations after introduction of FCW in the pond system. The FCW also successfully stabilized organic matter. CW further improved the removal efficiency in the range of 26% - 46%.

Table 1. Mean influent, effluent concentrations and improvement for pond system with without(w/o) and with(w) floating constructed wetland

S.No.	Parameter	Unit	Inlet	Outlet (w/o FCW)	Outlet (w FCW)	Improvement (%)
1.	pH	-	7.1	7.2	7.1	-
2.	Dissolved oxygen	mg/l	1.7	4.5	5.5	35
3.	TSS	mg/l	147.8	75.3	25	34
4.	COD	mg/l	320	195	58	42
5.	BOD	mg/l	234.3	85	25	25.7
6.	Ammonia-nitrogen	mg/l	12.03	7.7	1.5	51.5
7.	Ortho-phosphate	mg/l	7.6	3.7	1.6	27.6
8.	Total coliforms	Counts/100mL	2.1×10^6	5×10^3	220	0.22
9.	Faecal coliforms	Counts/100mL	1.1×10^6	4×10^3	150	0.35

The FCW also improved the nutrient removal efficiency. Ammonia-nitrogen reduction in the pond system with FCW was improved further by 51.5%. FCW have further reduced pathogens from the natural treatment system. In wetland systems, FC and TC are removed by various mechanisms including natural die-off and predation [4].

4,0 CONCLUSIONS

The results of this study show that FCW can be used to improve the treatment efficiency of pond systems. They not only improve the water treatment efficiency but also improve the aesthetics. Floating constructed wetlands can be applied as a sustainable, low cost and zero-energy technology for upgrading the existing pond treatment systems.

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