DESIGNING AND TESTING OF WASTEWATER IN CONSTRUCTED WETLAND USING PHRAGMITES KARKA

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ABSTRACT:

Constructed wetlands are cost effective in the wastewater treatment. The wetland technology is highly applicable in Asian countries. It is worked on various types of aquatic weeds or macrophytes. *Phragmites karka* is an emergent aquatic weed. It is promising emergent macrophytes for sustainable use in wastewater treatment due to its rapid growth. The present paper describes the use of *Phragmites karka* for wastewater (sewage) treatment using horizontal subsurface flow constructed wetland. The wastewater was treated with *Phragmites karka* using phytoremediation or rootzone bed technology. The physico-chemical parameters both before treatment and after treatment were analyzed and assessed for pollution load reduction. It is observed that wastewater was dark blackish, obnoxious and found highly offensive odour in before treatment but after treatment with *Phragmites karka* in constructed wetland, it was found clear and odorless. TS concentration was reduced by 61.64%, TDS by 60.37%, TSS by 63.19%, Hardness by 57.15%, Nitrate by 94.69%, Phosphate by 92.95%, BOD by 61.47% and COD was reduced by 64.74% after 96 hours of Hydraulic Residence Time. The results reveal that root zone

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technology is useful for treatment of wastewater so that the surface and ground water pollution load can be reduced.

KEYWORDS: Wastewater, Constructed wetlands, Phytoremediation, *Phragmites karka*, Horizontal Subsurface Flow.

INTRODUCTION:

Major water bodies all over the world are polluted by discharge of sewage and industrial wastewater. The waste water needs to be treated with low cost, an ecofriendly technology for sustainable future. The efforts can be made to treat the waste water using suitable aquatic weeds by using rootzone technology (Metcalf and Eddy, 1991., Chavan et al., 2009). Most of the water bodies both, surface as well as groundwater are polluted by anthropogenic activities. These water resources are polluted by the discharge of domestic sewage containing a large number of inorganic and organic impurities like high molecular weight compounds such as sugars, fats, oils, proteins from agro-industrial effluents, pathogens, bacteria, and viruses from sewage which can cause waterborne diseases. The wastes waste cause bad odour, colour and promote algal growth leading to eutrophication (Trivedy and Goel., 1986).

Rootzone or reed bed technology is an ecofriendly, self–contained, artificially engineered constructed wetland ecosystem. In this process the wastewater is allowed to flow laterally through specially prepared impervious bed in which specific wetland plants are grown. The root zone process is the natural remedy to the wastewater pollution problem. The root zone process has been fully commercialized to treat industrial and domestic effluents by the use of aquatic macrophytes in water pollution control **(**Brix and Schierup, 1989., Dhote., 2007). One of the integrated components of this process is the need of aquatic weeds. The plants grow in the wastewater by absorbing nutrients at faster rate turning these weeds to a desirable productive use. The plants hold themselves in the soil in the inter porous molecules of soil through their roots and rhizomes. These form an intricate network of underground stem. These roots grow rapidly. These growing roots provide air passages through the sludge. In turn, the sludge provides a host area for many biological communities to develop and continue to mineralize the sludge contents. The root zone helps to optimize the microbiological, chemical and physical processes naturally occurring in the wetland (Bates and Hentages, 1976; Hammer, 1989).

The wastewater is conducted horizontally along a seated path of porous bed reactor where oxygen is introduced biologically via helophytes. The porous bed material provides large surface area for the adsorption of bacteria which degrades organic load (Brix, 1994**)**. In densely rooted bed, the activity of microorganisms increases in terms of both, quality and quantity. The large contact area between water and the bed particles allow eliminating nitrates and phosphates by absorption and chemical precipitation. Beside, both the aerobic and anaerobic bacteria carry out active role in the reduction of COD and BOD which is evidenced in the present investigation. Such treatment helps to reduce the extent of groundwater contamination. This technique is suitable for the sustainable wastewater and wastewater management and may be preferred for recharging of groundwater **(**Rao and Mamatha, 2004., Vymazal, 2009).

MATERIALS AND METHODS:

Experimental procedures were similar to those described elsewhere (Chavan et al., 2009). For treatment of wastewater *Phragmites karka*, the most prominently adaptive marshy plant was used in the Horizontal Subsurface Flow constructed wetland. This plant is luxuriantly grown on margins of marshy places where the sewage enters into the water body. The plant was grown in a container of size 45x30x15 centimeter rectangular tub. The tub is used basically for the construction of bed with *Phragmites karka* plant. The holding tank of 16x11x32 centimeter with circular in shape (bucket) was used for the storage of untreated wastewater. The treatment bed was prepared with medium of gravel at the base, sand at the middle layer and soil as the top layer to support the plants and help for natural filtration of wastewater. Flow rates were adjusted by using Bucket and timer method. The Hydraulic Retention Time (HRT) adopted in the experiment was of four days (96 hours). The waste water was analyzed for its initial characterization and then passed drop wise trough the constructed wetland for the treatment. The treated water was collected at the outlet and was analyzed to find out the efficiency in terms of different pollution parameters. Similar observations are reported by Shivanand (2008).

The entire experiment was carried at room temperature under natural conditions outside the laboratory except the characterization. The analysis of wastewater before and after the treatment was carried out by using standard methods **(**APHA, 1998; Trivedi and Goel, 1986).

RESULTS AND DISCUSSION:

In the constructed wetlands using phytoremediation process typically requires few months for growth of vegetation, establishment of biofilm and sizable time for development of litter and standing dead compartments (Billore et al., 1999).

In the root zone treatment system the reed grass with rhizomes and rhizospheres plays key role in the treating the wastewater. The striking observations indicate that the deep roots and rhizomes create a large volume of active rhizospheres per unit area. The important function of the *Phragmites* plant in the constructed wetland is to supply oxygen to the heterotrophic microorganisms in the rhizospheres. It also helps to increase the hydraulic conductivity of the soil. Maeseneer and his coworkers (1982) have proved that the roots and rhizome penetrate through the soil and loosen the soil creating increased porosity by forming pores of tubular shape. The roots and rhizomes leave horizontally through interconnected channels upon executing the role of decaying. According to Kickuth (1980) these microspores stabilize the hydraulic conductivity in the rhizosphere at a level equivalent to coarse sand within 2-3 years regardless of the soil environment.

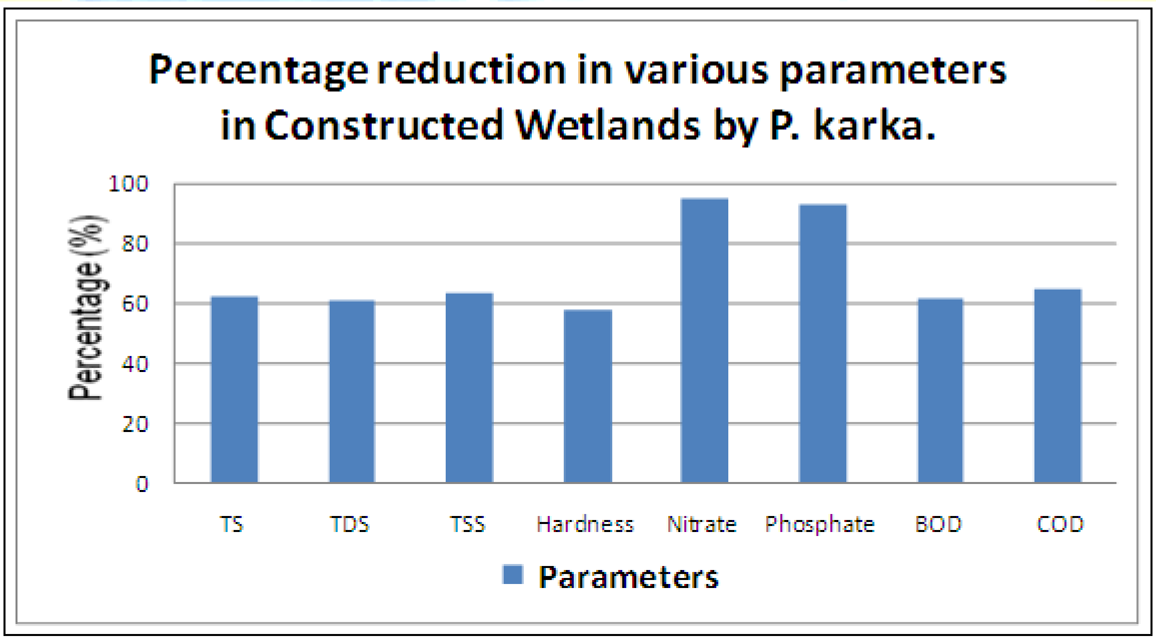
In this study, collected wastewater initially was having turbid colour, full of dirt containing total solids as high as 5893 mg/L with total dissolved solids up to 3230 mg/L and total suspended solids up to 2663 mg /L. The hardness was 619 mg/L, nitrate was 4.45 mg/L, phosphate was 3.65 mg/L, BOD was 1848 mg/L and COD was 2465 mg /L respectively. The results are summarized in **Table 1**.

Table 1: Change in characteristics of effluent before and after the treatment with *Phragmites karka*.

Sr. No.	Pollution Parameters	Analysis Without using test plant	With using test plant	Pollutants Removal in %
1	pH	7.9	7.4	Near Neutral
2	TS (mg/L)	5893	2260	61.64
3	TDS (mg/L)	3230	1280	60.37

4	TSS (mg/L)	2663	980	63.19
5	Hardness (mg/L)	619	267	57.15
6	Nitrate (mg/L)	4.45	0.23	94.69
7	Phosphate (mg/L)	3.65	0.29	92.95
8	BOD (mg/L)	1848	712	61.47
9	COD (mg/L)	2465	869	64.74

Fig.1: Showing Percentage reduction in various parameters in Constructed Wetlands by Phytoremediation.



The analysis of final effluent indicated that constructed wetland is capable to treat the wastewater and reduced TS by 61.64%, TDS by 60.37%, TSS by 63.19%, Hardness by 57.15%, Nitrate by 94.69%, Phosphate by 92.95%, BOD by 61.47% and COD reduced by 64.74% respectively by BOD up to 21.95%, COD upto 33.61%, remove hardness upto 57.15% and nitrates and phosphates upto 94.69 and 92.95% respectively in four days or 96 hrs **(Fig.1)**. Koottetep et al., (2002) reported similar findings based on the one year performance data. A series of constructed wetland unit was found to be highly efficient in treating wastewater from

Eastern Seaboard Industrial estate (ESIE). The wastewater was efficiently treated with constructed wetlands and technology was capable to results in the BOD, COD, SS and Nitrogen removal efficiencies of 96%, 91.7%, 90% and 81% respectively.

CONCLUSION:

The root zone using *Phragmites karka* is suitable for the treatment of wastewater and is quite efficient for the pollution reduction in terms of Solids, BOD, COD, organic, inorganic materials and other physicochemical parameters.

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