VERTICAL FLOW CONSTRUCTED WETLAND FOR FOOD INDUSTRY WASTE WATER

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Abstract - *One of the most trusted and low maintenance and low in operation costs of wastewater treatment is the setup of and operation of a Vertical Flow Constructed Wetland. These wetlands systems have a very good ability to handle the sudden increase in the amount of food industry wastewater and sudden increase in a load of various contents of the wastewater. The plant here used in this wetland setup is Canna Indica. The plant was specifically chosen for its growth of roots and development of rootzone in the soil providing more contact area and substrate for the microorganisms for their processing and playing an important role in the treatment of wastewater.*

A constructed wetland unit of capacity 24 liters was constructed to treat the food industry wastewater with COD and BOD values of 544 and 270 mg/L respectively. The wetland media consisted of soil and a fine aggregate bed. The bed is filled to a height of 15cm with soil of size 2 µm. The soil used for the growth of plants is black soil as seen in below fig

3.11 for a depth of 15cm. and fine aggregate depth is 5cm, size 300 µm. The plant used in this treatment is canna Indica. About 40 Elephant ears of an average size of 30 cm are used in the constructed wetland.

From the test reports, it was observed that all the pollutants were reduced to 50-80%. The highest BOD and COD removal occurred at the retention time of 6 days. The Canna indica plant showed good efficiency. The average removal of TDS, Nitrate, and Phosphate for a retention time of 1, 2, 4, and 6 days was 60%, 75%, 80 and 90% respectively. The treated water can be used safely for household works and irrigation purposes as the test results were within the IS standard limits. There was an increase in the height of the plant about 2-3cm averaging from the actual height. Hence the overall removal efficiency of plant elephant ear was proved to give better efficiency compared to conventional plants. This method can be used for small-scale food industry wastewater.

***Key Words*: waste water treatment, BOD , COD , wet land**

1. INTRODUCTION

In India major sources of water pollution are food industry wastewater, industrial effluent and run- off from agriculture. The biggest and most important environmental problem and danger to human health is generation of wastewater and its contamination in the surroundings as well as the penetration in the fresh and potable water. With the increase in population the food industry-wastewater generation rate is getting higher and is growing exponentially. There is a need to treat the wastewater before its discharge in to the environment where the flora and fauna thrives.

For the treatment of wastewater, vertical flow constructed wetlands (VFCW) have been the subject of extensive research in recent years. These systems have a higher oxygen transfer rate than conventional horizontal flow built wetlands, which allows them to accomplish higher levels of organic matter removal and nitrification. Numerous experiments have focused on additional VFCW aeration improvements. The requirement for periodic changeover between parallel beds to prevent clogging of the surface and the still-limited aeration are two major limitations that these systems still have. The main obstacle to establishing field-scale artificial wetlands in India is the lack of huge land areas. Although the subsurface vertical flow networks are typically 100 times smaller the surface flow's size range and three times smaller HRTs. Given that it has been demonstrated to be successful in treating various types of wastewater all over the world, including India, the vertical flow design seems to have an implication for improved acceptability under Indian conditions. Until now, it has been understood how plants work to treat various types of wastewater. Plants enhance the surface area available for the growth of bacteria, which in turn creates bio-film and transports oxygen up to 90% of the way through the system.

Objectives

- To develop a small scale Experimental model for the treatment process.
- To determine the characteristics of food industry waste water.
- To determine the overall efficiency of Canna indica aquatic plant.

CHARACTERISTICS OF WASTEWATER

WETLAND CONSTRUCTION

A less expensive and low-cost alternative option for wastewater treatment is the use of wetlands, whether artificial or natural. Constructed Wetland Treatment System (CWTS) refers to a constructed wetland system that is expressly engineered with improving water quality as one of its key goals. For the treatment of small volumes of wastewater containing easily degradable organic matter for isolated populations in urban settings, numerous such systems were built in the past. The worldwide adoption of CWTS is currently being propelled by broad demand for enhanced receiving water quality as well as water reclamation and reuse. The use of wetlands for wastewater treatment is commonplace throughout the world due to its capacity to change and store organic materials and nutrients..

A constructed wetland comprises of the following five major components:

- Basin
- Substrate
- Vegetation
- Liner
- Inlet/Outlet arrangement system

ADVANTAGES OF WETLAND PROCESS

- Long life and robustness
- Lower Cost
- Adaptability & Flexibility of treatment:
- Simplicity and auto-organization
- Aesthetics
- Highly productive system and Water saving
- No additional pollution nor chemical product
- Protection of vital ecosystems

INCONVENIENT/CHALLENGES

- Space
- Lack of Professionalism/Experience
- Local terrain not always adapted / possible
- Ignorance by public health officials and engineers
- Significantly longer design phase
- Construction
- Inter-sectorial collaboration
- Maintenance

2. METHODOLOGY

ABOUT PLANT USED IN PROJECT (CANNA INDICA)

A member of the Cannaceae plant family, Canna indica is also known as Indian shot, African arrowroot, tasty canna, purple arrowroot, and Sierra Leone arrowroot. Most of South America, Central America, the West Indies, and Mexico are its natural habitats. Along with much of Europe, sub-Saharan Africa, Southeast Asia, and Oceania, it has also become naturalized in the southeast of the United States (Florida, Texas, Louisiana, and South Carolina). Depending on the type, the canna indica perennial can grow to a height of between 0.5 m and 2.5 m. It is frost delicate and hardy to zone 10. Hermaphrodite blooms are present. Through artificial wetlands, Canna indica sp. can be employed for the treatment of industrial waste waters. High organic loads, color, and chlorinated organic compounds can be effectively removed from paper mill wastewater using this method.

Growth of the vegetation was measured here using the heights of the plants as they showed good height during the operational phase also there were shoots developing in the canna Indica and they were used to develop the flowers of yellow color as well as the height of the plants were during the initial stage of growth were having a registered height of 25 cmand as the operation started and wastewater was added in them they had a total growth of 60cm in a time span of 1 year.

CONSTRUCTED WETLAND UNIT

- Three plants are planted in the built wetland in the soil at the top with a depth of 15cm. All of the plants are carefully spaced apart to guarantee that each plant grows uniformly.
- The second layer following the soil in which plants are planted is fine aggregate with a 5cm height. The soil layer in which the plants are placed is also 5cm tall.All the layers are separated by a small thin layer of mesh which helps in retaining the materials in their own layers because it inhibits material mixing and outflow in the treated water sump. The mesh also aids in preventing the mixing of one layer with another.
- The containers in which all of these supplies are stored are 40cm x 30cm x 10cm.
- At the bottom of each box, there are 8mm diameter holes spaced 5 cm horizontally and vertically.

DETAILS OF THE LAYERS

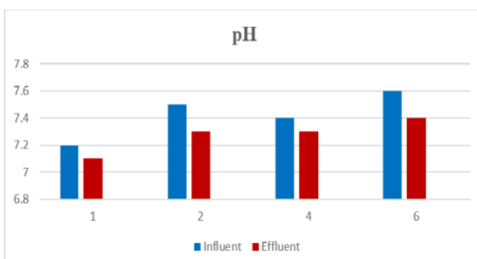
Sl.No	Layers	Size	Depth (cm)
1.	Soil	2 µm	7.5
2.	Fine sand	300 µm	7.5
3.	Coarse sand	600 µm	15
4.	Fine aggregate	5mm	15
5.	Coarse aggregate	20mm	7.5
6.	River pebble	30-50mm	7.5

The experiments are carried out for treating Food industry waste wastewater in a Vertical Flow constructed wetland. The characteristics of the samples such as pH, BOD5, COD, Total solids, potassium, Nitrate, phosphate is to be analyzed as shown in the Table.3.1. Experiments are conducted using plant Canna Indica in the constructed wetland system for a Hydraulic retention time of 1, 7, and 14 days loading. Waste water is allowed to stand for the provided retention time so that plant absorbs the nutrients present in the food industry waste water. The treated wateris collected from the constructed wetland in the Cans and taken for the analysis of different parameters and comparing with the Characteristics of Influent wastewater in the main laboratory situated at PDA College of Engineering Kalaburgi, Karnataka

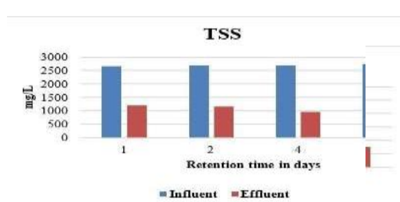
Physico-Chemical Parameters

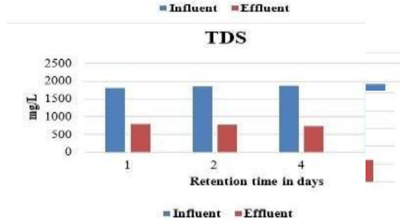
Parameter s	Methods	Equipment's
Colour	Visual comparison method	-
Odour	Detecting by nose	-
pH	Electrometric	pH meter
BOD	Winklers method	BOD incubator
COD	Open reflux method	Reflux flask
TDS	Gravimetric Analysis	Electronic balance
TSS	Gravimetric Analysis	Hot air oven
Nitrate (No3)	Phenol disulphonic acid (PDA) method	Spectrophotometer
Phosphate	Stannous Chloride Method	Spectrophotometer
Potassium	Flame photometry method	Flamephotometer
Chloride	Argentometric method	Glass wares
Sodium	Flame photometry method	Flamephotometer

3.RESULT

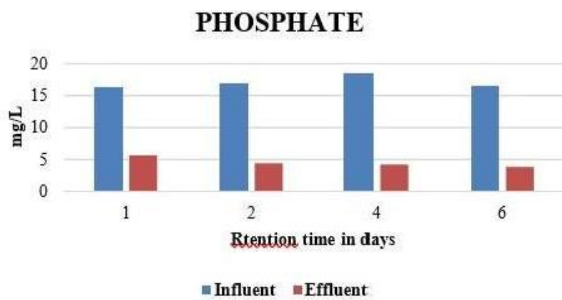


The pH Value of the Food idustry wastewater has been growing and dropping for each distinct retention duration of loading, with no ideal pattern.Total solids are one of the primary factors that have been eliminated in the created wetland system. It was decreased from 2740mg/L to 758 mg/L with a 72% elimination throughout the sample's 6-day retention in CW. During the retention times of 1, 2, and 4 days, the percentage reduction of TS was 55%, 56%, and 64%, respectively.



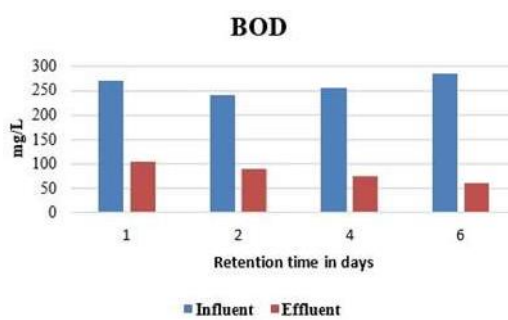


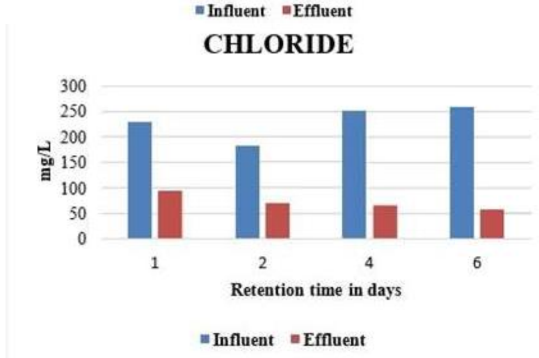
Total solids is one of the major parameter that has been removed in the constructed wetland system. It has been reduced from 1908 mg/L to 622 mg/L with a removal of 67% during 6 day retention of sample in CW. The percentage removal of TS observed during the retention time of 1, 2 and 4 days was 55%, 57% and 60% respectively.



3. RESULTS

Phosphate which changes to orthophosphate was observed in the roots of CW plants. The transformation process that occurred was influenced by biotic environmental factors such as sunlight, air, and soil used for the CW and biotic factors such as microbes and aquatic plants.The Phosphate of Food industry wastewater was reduced in CW during different retention times for1, 2, 4, and 6 days of loading. The removal efficiency was increased from 74%, 80%, 82% and 83% respectively as shown in below fig 4.2.5. The maximum removal efficiency was observed for 6 days retention time which is about 82%. The Phosphate content present in the soil sample was reduced from 1.2 mg/L to 0.8 mg/L.





BOD is one of the major parameter that has been removed in the constructed wetland system. It hasbeen reduced from 285 mg/L to 80 mg/L with a removal of 78% during 1 day retention of sample in CW. The percentage removal of BOD observed during the retention time of 2, 4 and 6 days was 62%, 70% and 80% respectively. This reduction inthe BOD value indicates that the Canna Indica plant is effective in the treatment of Food industry wastewater since BOD is one of the major parameters to be minimized in the treatment process. The organic matter present in the wastewater sample was breakdown into simpler matter due to the presents aerobic bacteria. Hence their was reduction in the BOD concentration. Along with reduction of the BOD value, constructed wetland has also decreased the value of COD.

The maximum reduction of COD Was observed during the Retention time of 6 days of sample in the wetland system with a %removal of 85%. For a Retention time 1, 2 and 4 day, the reduction was about 75%, 80% and 81% respectively. Hence the Canna indica was effective in removing COD concentration to the desirable limit as per IS 10500 2012.

The chloride of Food industry wastewater was reduced in CW during different retention times for 1, 2, 4, and 6 days of loading. The removal efficiency was increased from 58%, 61%, 73% and 77% respectively. The maximum removal efficiency was observed for 6 days retention time which is about 77%..The nitrate of Food industry wastewater was reduced in CW during different retention time for 1, 2, 4 and 6 days of loading. The removal efficiency was increased from 87%, 90%, 92% and 95% respectively. The maximum removal efficiency was observed for 14days retention time which is about 95%.The nitrate content present in the soil sample was reduced from 95 mg/L to 87 mg/L. It is due to because of the nitrate content uptake by the plants in the CW. Nitrate was utilized by wetland plants as nutrient for its growth.

4.CONCLUSION

- *Effective wastewater treatment solutions have been demonstrated using vertical flow built wetlands technology, stressing the cheap cost of installation and operation.*
- *Its use in the treatment of a wide range of contaminants caused by various human activities. VFCW facilities are promising technologies that function efficiently and effectively for wastewater treatment and management.*
- *Canna indica, employed as an aquatic plant in a created wetland, has a high performance for the treatment of food sector effluent.*
- *According to the results of the analysis, all contaminants were decreased by 50-90 percent. At a retention time of 6 days loading, the maximum BOD and COD elimination occurred. The elephant ear plant removed salt and potassium with a removal rate of 70% and 80%, respectively*.
- *For retention times of 1, 2, 4, and 6 days, the percentage removal of TDS, Nitrate, and Phosphate was 70%, 80%, 85%, and 90%, respectively.*
- *Because the test findings were within the IS 10500 2012 standard limits, the treated water may be utilized safely for domestic tasks and irrigation. The plant's height increased by roughly 2-3cm on average from its original height.*

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