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Root Zone Treatment for Periyakulam Pond in Coimbatore

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ABSTRACT

Water quality on earth is depleted due to over increasing human development activities that over exploits and affect the quality and quantity of the water resources. The rapid urbanization has resulted in pollution of fresh water bodies due to increase generation of domestic waste, sewage, industrial waste etc. Coimbatore is an important industrial city located in the state of Tamilnadu. The paper deals with the Root Zone Treatment for Periyakulam Pond in Coimbatore. The main source of pollution to the pond is from the discharge of domestic and industrial effluent into the pond. Mechanically treated waste water is led horizontally through the rhizosphere of wetland plants. During the passage of the waste water through the rhizosphere, the waste water is cleaned by microbiological degradation and by physical or chemical processes. The wetland plants supply oxygen to the heterotrophic micro organisms in the rhizosphere and stabilize the hydraulic conductivity of the soil. The parameters such as ph, Electrical Conductivity, Turbidity, Biochemical Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Total Dissolved Solids, Nitrogen, Phosphorous and Potassium are analysed. It is concluded that Root Zone Treatment plan seem to be a viable alternative to conventional waste water treatment technology, especially for small to medium sized communities. The result obtained indicates that the Root Zone System works effectively and treated water can be used for recreational activities like washing clothes, fishing, swimming, irrigation etc.

Keywords: Root Zone, Constructed wetland, biochemical oxygen demand, Sedimentation, Absorption and Nitrification.

1. INTRODUCTION

In the recent years increasing production and disposal of wastewater have caused an accelerated eutrophication of receiving waters. Therefore there is an increasing demand for removing the nutrients, nitrogen and phosphorous as well as the organic content present in wastewater prior to their disposal into streams. Root Zone is a scientific term used to cover all the biological activity among different types of microbes, the roots of plants, water soil and the sun. Root zone treatment systems are artificially prepared wet lands comprising of clay or plastic lined excavation and emergent vegetation growing on sand/gravel mixtures and is known as constructed wet lands. It is an attractive and alternative system for wastewater management.

In this system, the plants conduct oxygen through their stems into their root systems and create favourable conditions for the growth of bacteria. The waste water flows through the root zone in a horizontal or vertical way where the organic pollutants are then decomposed biochemically by bacteria present in the rhizosphere of root zone plants. The filter media are hence selected carefully to provide favourable conditions for both plants, bacterial growth and avoid clogging. The filtering action of the soil bed, the action with fungi etc. and chemical action with certain existing or added inorganic chemicals help in finally obtaining very clear and clean water. The system of plants regenerates itself as the old plants die and form useful humus and hence makes the system maintenance free with a life span of around 50 to 60 years without any loss in efficiency.

Industrialization and the rate of population in Coimbatore city is increasing day by day. Hence the demand for good quality of water is also rising on daily basis. The responsibility of providing good quality of water for drinking purposes, domestic purposes and industrial purposes entirely lies in the hands of present and future engineers. These points led to the need of focussing on the present status of Periyakulam pond and to adopt the effective root

zone treatment process. The main source of pollution of pond is due to the discharge of domestic and industrial effluents into the pond thus decreasing the quality of water day by day. This paper deals with the monitoring of polluted water before the treatment process and the necessity to protect the natural environment from waste related processes after the treatment process.

2. ROOT ZONE TREATMENT

Root Zone Treatment systems are artificially prepared wetlands comprising of clay or plastic lined excavation and emergent vegetation growing on sand /gravel mixtures and is known as constructed wetlands.

The term Root encompasses the life interactions of various species of bacteria, the roots of selected varieties of plants, sand, sun and water. They are also known as constructed wetlands or subsurface flow system. In this system the plants conduct oxygen through their stems into their root system and create favourable conditions for the growth of bacteria .The waste water flows through the root zone in a horizontal or vertical way where the organic pollutants are decomposed biochemically by bacteria present in the rhizosphere of root zone plants. The filter media are selected carefully to provide favourable conditions for both plants, bacterial growth and avoid clogging.

2.1. Types of Root Zone Treatment

Two types namely,

1. Horizontal Root Zone Treatment
2. Vertical Root Zone Treatment

2.1.1. Horizontal Root Zone Treatment

In this process the flow of water to the root zone of the plant is in horizontal manner. For horizontal RZTS the plants can be selected which are deep rooted and oxygenate the rhizosphere to the roots.

2.1.2. Vertical Root Zone Treatment

In this type of process the oxygen input is enhanced by the intermittent surface application and hence the plant selection is less critical .The flow of water to the root zone is in vertical manner.

3. MATERIAL AND METHODS

The present root zone system is situated at Periyakulam pond in the city of Coimbatore in the state of Tamilnadu between the altitude 11 05' 38" N and 77 05'38" E. The total area of pond is 337acre and catchment capacity of pond is 63sqkm and storage capacity is 97MCft.

The parameters such as pH, Biochemical oxygen demand, chemical oxygen demand, dissolved oxygen, total dissolved solids, nitrogen, phosphorous and potassium are analyzed before and after treatment. The Horizontal root zone treatment process is adopted.

3.1. Role of Micro Organisms

The degradation of organic matter and de nitrification of nitrogen are mediated to plants by micro organisms. The leakage of oxygen from roots of macrophytes creates oxidized zones around the roots .In addition, ammonia is oxidised to nitrate by nitrifying bacteria in these zones. By these processes nitrate is converted into free nitrogen, which evaporates into atmosphere. Thus efficient decomposition of organic matter and nutrient matter and its removal is necessary in this method.

3.2. Role of soil

The soil provides a stable surface area for microbial attachment, a solid substrate for plant growth, and functions directly in purification of wastewater by way of physical and chemical processes. Soils are very effective in removing suspended solids, pathogenic bacteria and viruses by filtration and absorption. Nutrients are removed from water, flowing through soil. Precipitation and co precipitation processes in soil are more permanent manner by which certain ions are removed from wastewater.

3.3. Planting methodology

The plants are transferred from soil media to sand media. Initially the plants are watered sufficiently. The stabilization process is continued for nearly 15 days. After stabilization process the plants are transferred to treatment tank.

3.4. Sampling procedure

Samples are collected for various examinations at different points, at some 4 sample stations .At each sample stations 70 litres of water is collected using a plastic container. Then physio-chemical examinations are done in laboratory.

3.5. Details of tank:

The shape of tank is rectangular type, which has dimensions of 1.2meters by 0.6meters with depth of 0.6 meters. The tank is divided into 3 chambers at distances of 230mm, 760mm, 230mm. The inlet chamber is used for loading the water which is to be treated. The second chamber is used for growing plants and third chamber for collecting the treated water. Sufficient hoes are given, for flow of water into the root zone of plant from inlet chamber. In the inlet

chamber 4holes of 25.4mm diameter is given at a height of 304.8mm from bottom of tank. The holes are fitted with galvanized iron pipe which connects inlet chamber and root going area of tank.

The perforated hole in galvanized iron pipe conveys water which is to be treated from inlet chamber to the roots of the plant. A gap of 25.4mm is provided at the bottom end of second chamber for collection of treated water. The water collected in the outlet chamber is used for further analysis purpose.

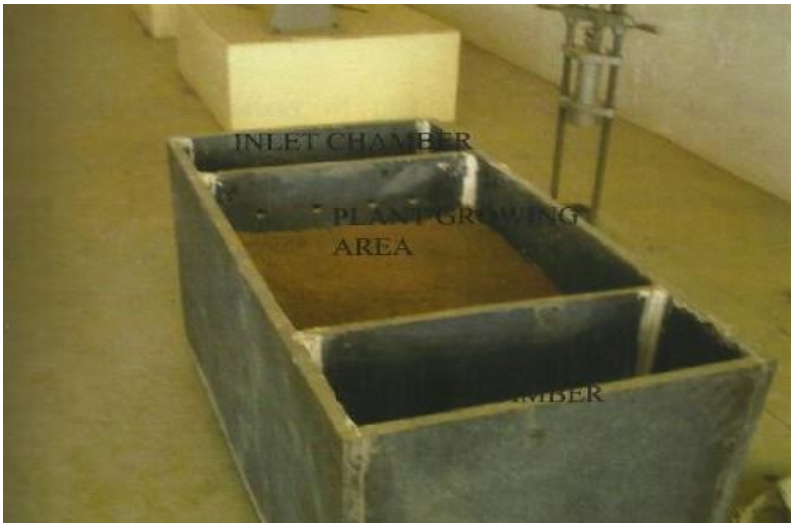

Figure 1. View of tank

3.6. Agents filed in the tank

The first layer of second chamber is filled with gravel to a depth of 150mm.The second layer of the tank is filled with sand to a depth of 450mm.The stabilized plants are planted in the second layer. The galvanized iron pipe connected from inlet chamber to second chamber with perforated holes provides water to root zone of plants.

Figure 2. Agents filled in the tank

3.7. Detail of Plant Used for Root Zone Treatment

A wide variety of plants are available for root zone treatment system example Typhalatifolia, colacasia, reed typha, canna etc. The species of plant that is selected for root zone treatment is Typhalatifolia, these plants are highly efficient in treating the polluted water. Then the tests that are conducted include pH, chemical oxygen demand, biochemical oxygen demand, nitrogen, phosphorous and potassium.

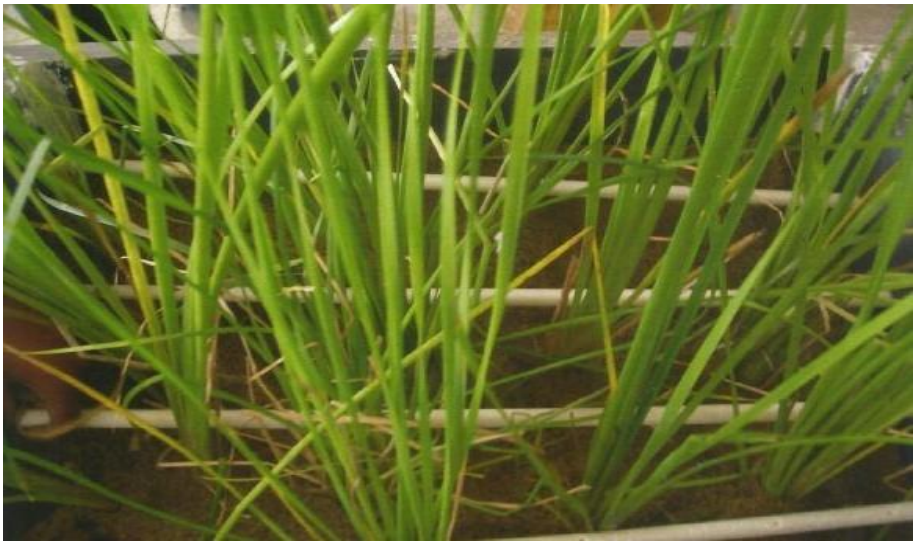

Figure 3. Typhalatifolia planted for root zone treatment

Figure 4. Growth of root before treatment

Figure 5. Growth of root after treatment

4. RESULTS AND DISCUSSIONS

Table 4.1 Quality of water before treatment and after treatment for root zone treatment

S. No	Experiments	Inlet Sample Values	Outlet Sample Value at 3 and Half Days Interval	Outlet Sample Value at 7 Days Interval
1	pH	8.90	7.95	7.0
2	Total dissolved solids (TDS)	0.24mg/l	0.13mg/l	0.10 mg/l
3	Dissolved oxygen(DO)	3.2mg/l	3.8mg/l	4.0 mg/l
4	Chemical oxygen demand(COD)	1000mg/l	900mg/l	850mg/l
5	Biochemical oxygen demand(BOD)	90mg/l	75mg/l	68mg/l
6	Nitrogen (N)	35mg/l	21mg/l	15mg/l
7	Phosphorus(P)	0.6mg/l	0.5mg/l	0.2mg/l
8	Potassium(K)	7mg/l	5.7mg/l	4.3mg/l

4.1. pH

It is a term used universally to express the intensity of acid or alkaline condition of water. It is a measure of hydrogen ion concentration, or more precisely, the hydrogen ion activity. Initially the value of pH was found to be 8.92 before treatment process and then after treatment for 3 and half days interval then the value of pH was decreased to 7.95 and then the sample was collected at 7 days interval and the value of pH was found to be 7.

4.2. Total Dissolved Solids (TDS)

The total dissolved solids which usually predominate in water consist mainly of inorganic salts, small amount of organic matter. The initial amount of total dissolved solids was found to be 0.24g/liter and by days pass on by the development of Root Zone of plant the value was found to be 0.13g/liter at 3 and half days and 0.10g /liter at seven days interval.

4.3. Dissolved Oxygen (DO)

Oxygen is dissolved in most water in varying concentrations. Solubility of oxygen depends on temperature, pressure and salinity of water. It is essential to the life of fish and other aquatic organisms. Initially the value of dissolved oxygen was found to be 3.2mg/liter and after treatment for 3 and half days the value of dissolved oxygen effectively increased to 3.8mg/liter and then after 7 days of treatment the value increased to 4.2mg/liter.

4.4. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is a measure of organic matter present in water. Initially the COD was found to be high value of 1000mg/liter and by days passed on to 3 and half days of treatment process the value of COD was found to be 850mg/liter and after 7 days of treatment value was found to be 600mg/liter.

4.5. Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand is a test of great value in the analysis of sewage water, industrial effluents and polluted waters. BOD refers to the quantity of oxygen required by the bacteria and other micro organisms in the biochemical degradation and transformation of organic matter under aerobic conditions. The initial value of BOD was found to be 90mg/liter and after treatment for 3 and half days the value of BOD was found to be 75mg/liter and further treatment for next 3 and half days the value of BOD decreased to 68mg/liter.

4.6. Nitrogen (N)

The presence of Nitrogen in water indicates the presence of organic matter. Initially the Nitrogen content in the polluted water was found to be 35mg/liter and after development root for a period of 3 and half days the value was found to be 21mg/liter and after the treatment for next 3 and a half days interval the value of Nitrogen considerably reduced to 15mg/liter.

4.7. Potassium (K)

Potassium is an essential nutritional element but in excessive amounts it acts as a cathartic. The initial value of potassium in polluted water is found to be 7 mg /liter and after treatment for 3 and half days the value of potassium

reduced to 5.7mg/liter and again treatment was given for further 3 and half days and value was found to be 4.3mg/liter.

4.8. Phosphorous (P)

The value of Phosphorous for raw water is found to be 0.6mg/liter and after treatment for 3 and half days the value was found to be 0.5mg/liter and further treatment for 3 and half days the value was found to be 0.2mg/liter.

5. CONCLUSION

In the Root Zone Treatment process of polluted Periyakulam Pond water various constituents like pH, total dissolved solids, chemical oxygen demand, Biochemical Oxygen Demand, Dissolved Oxygen, Nitrogen, phosphorous and potassium are analyzed. The treatment process presents an effective way to treat the polluted water in the pond. The treated sample waters were collected at 3 and a half days interval and 7 days interval. Monitoring of water was proceeded as per the standard procedures. The effect of Root Zone Treatment on polluted Periyakulam Pond water was deemed fruitful. Root Zone Treatment System is a effective technique for treating the polluted water.

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