Treatment of Institutional Wastewater using the potential of Azolla

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Abstract : Water being the source of life has become a scarce resource in this millennium. Since the limited resource availability, reuse of the available supply is more suggestible. Loads of wastewater get generated from institution, industrial, commercial and domestic origins and are discarded. Phytoremediation converts this wastewater into usable water with the help of plants. This is a very eco-friendly technique which decontaminates the wastewater in a very economical way. Azolla is a good phytoremediation and can be used for the treatment of wastewater. The core aim of this study is the organic removal efficiency in terms of COD usisng Azolla plant as a sorbent. The maximum COD removal efficiency was attained 94.73% at an HRT of 5 days with an OLR of 0.026 Kg/COD/m3.day.

IndexTerms **- Azolla, Biochemical Oxygen Demand, Chemical Oxygen Demand, pH, Phytoremediation, Wastewater.**

I. INTRODUCTION

In recent times, institutional wastewater has become a matter of concern because of its potential hazardous effect. A satisfactory level of study to minimize this problem is yet to be reached because of various limitations. The raw institutional wastewater contains various toxic organic and inorganic compounds, chemicals, pathogenic microorganisms etc. If they are released into the environment without any treatment, our natural water bodies will be severely affected by them. For this, the wastewater must be treated before releasing into the environment. The treatment includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. (R.Ranjon Roy et al., 2016). The content of the wastewater can vary, but the main characteristics are: pH, Dissolved Oxygen.

Phytoremediation

Phytoremediation is the use of plants and associated biodegrading microorganisms to remove or detoxify environmental contaminants. It has been an emerging green technology over the past few decades (Pilon-Smits, 2005; Cofield et al., 2007). Plants have the ability to uptake inorganic pollutants such as Fe, Cd and Pb, and to breakdown organic contaminants. Organic pollutants are most often reduced in the rhizosphere, but can also be sequestrated, volatilized, and degraded by the plants. Phytoremediation is appropriate for fixed budgets as an environmentally sustainable alternative to current costly practices of excavation and incineration (Pilon-Smits, 2005).

Phytoremediation is a cost-effective plant-based approach of remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to metabolize various molecules in their tissues. It refers to the natural ability of certain plants called hyper accumulators to bioaccumulation, degrade, or render harmless contaminants in soils, water, or air. Toxic heavy metals and organic pollutants are the major targets for phytoremediation. Knowledge of the physiological and molecular mechanisms of phytoremediation began to emerge in recent years together with biological and engineering strategies designed to optimize and improve phytoremediation. In addition, several field trials confirmed the feasibility of using plants for environmental cleanup. Phytoremediation is one of the biological wastewater treatment methods and is the concept of using plant based system and microbiological processes to eliminate contaminants in nature. The remediation techniques utilize specific planting arrangements constructed in wetlands, floating plant system and numerous other configurations.

The basic principle behind phytoremediation is that plants such as algae, fungi, grasses, forbs, shrubs, trees, etc. to extract pollutants found in soil,water and air. In phytoremediation system are to clean up contaminated water which includes identification and implementation of efficient aquatic plants uptake of dissolved nutrients and heavy metal by the growing plants and harvest and beneficial use of the plant biomass produced from the remediation system.

The most important factors in implementation phytoremediation is the selection appropriate plant which should have high up take of both organic and inorganic pollutants grow well in polluted water and easily controlled in quantitatively propagated dispersion. The uptake and accumulation of pollution or pollutant vary from plant to plant and also from species to species within a genus.

Classification of Phytoremediation

Many classification of phytoremediation under the following in describe below.

Phytosequestration: Phytochemical complexation in the root zone, reduce the fraction of the contaminant that is bioavailable. Transport protein inhibition on the root membranepreventing contaminants from entering the plant. Vascular storage in the root cell contaminants can be sequestered into the vacuoles of root cells.

Phytoextraction: Uptake and concentration of substances from the environment into the plant biomass.

Phytostabilization: Reducing the mobility of substances in the environment. For example, by limiting the leaching of substances from the soil.

Phytotransformation: Contaminants are taken up into the plant tissues where they are metabolized, or biotransformed. Where the transformation takes place depends on the type of plant and can occur in roots, stem or leaves often resulting in their inactivation, degradation (phytodegradation), or immobilization (phytostabilization).

Phytostimulation: This takes place in the soil or groundwater immediately surrounding the plant roots. Exudates from plants stimulate rhizosphere bacteria to enhance biodegradation of soil contaminants. This process is also known as rhizosphere degradation. Phytostimulation can also involve aquatic plants supporting active populations of microbial degraders, as in the stimulation of atrazine degradation by hornwort.

Phytovolatilization: Removal of substances from soil or water with release into the air, sometimes as a result of phytotransformation to more volatile and/or less polluting substances.

Rhizofiltration : Filtering water through a mass of roots to remove toxic substances or excess nutrients. The pollutants remain absorbed in or adsorbed to the roots.

Biological hydraulic containment: Some plants, like poplars, draws water upwards through the soil into the roots and out through the plant decreases the movement of soluble contaminants downwards, deeper into the site and into the groundwater.

2. Materials and Method:

Azolla was collected from local market for initial seeding in the laboratory. Experiments were done after acclimatization of plants through serial exposure of wastewater starting from 25% concentration to gradually increasing the concentration to 100%. Treated institutional wastewater was collected from M/s. Annamalai University, Annamalai nagar, Chidambaram and characteristics of the effluent were analyzed as per the procedure given in the Standard method for water and wastewater (APHA,2017).

Wastewater source and its characteristics:

A Laboratory scale phytoremediation reactor was fabricated with a working volume of 79 litre is made up of Plexi glass with an influent and effluent tanks. The experiment was based on completely randomized design shown in Figure 1. The complete plant configuration details are given in Table 1.

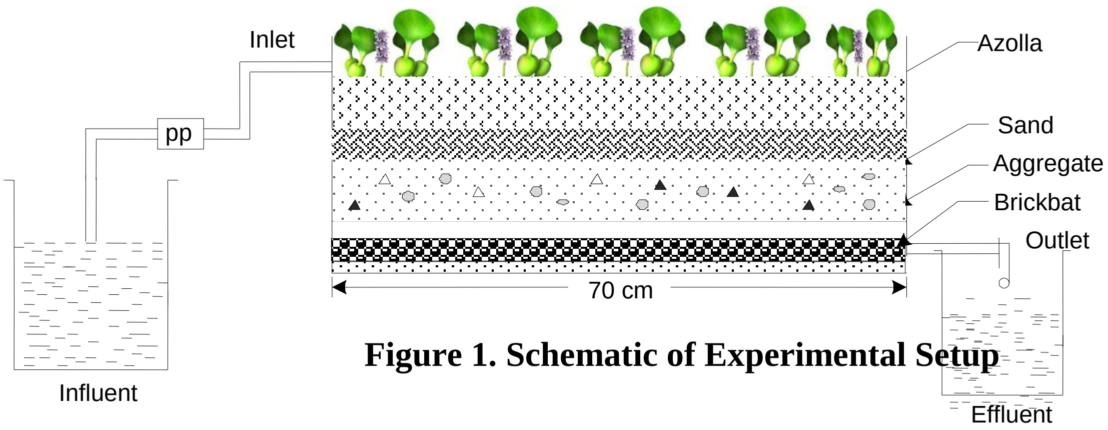

Figure 1. Schematic of Experimental Setup

Table 1. Physical configuration of Phytoremediation Plant

Parameters	Dimensions
Length	70 cm
Breadth	25 cm
Height	45 cm
Free Board	9 cm
Total Volume	79 litre
Working Volume	68.25litre
Thickness of Plexi Glass	6 mm
Peristatic Pump	PP-30

Hydraulic Retention time

Hydraulic Retention time also known as hydraulic residence time is a measure of the average length of time that a soluble compound remains in a constructed reactor. Hydraulic Retention time is a volume of the storage unit divided by the influent flow rate. The effective volume of the reactor and flow rate were interpreted for the different Retention time, such as 1, 1.5, 2, 2.5, 3, 3.5, 5 and 6 days.

Organic Loading Rate

Organic loading rate is defined as the application of soluble and particular organic matter. The COD of the different real wastewater stream and the corresponding flow rate were correlated with the effective volume of the reactor. The observed values vary from 0.026 to 0.649 kg COD/m^3.d.

3. RESULT AND DISCUSSION

The characteristics curves were drawn for the influence of COD with respect to Hydraulic Retention Time (HRT) as shown in Figure 2, 3 and 4. With the HRT of 6 days the COD falls from 6.3, 5.6, 3.4, 8.7, 7.9, 7.4, 8.2 and 5.3 and the value of COD slightly fluctuate during this stage indication.

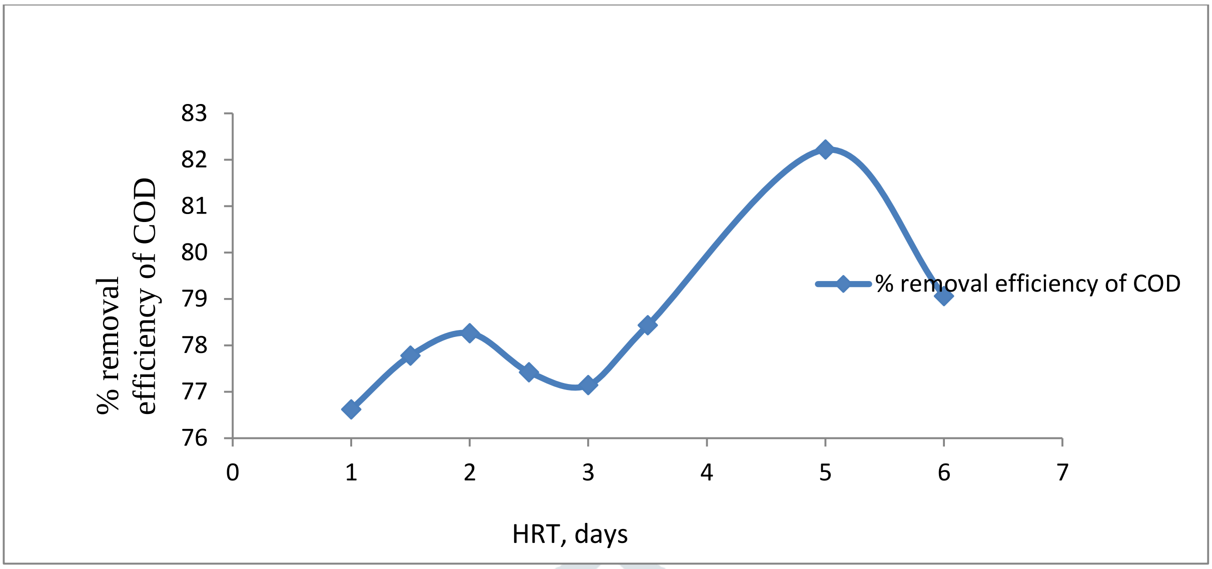

Figure 2. HRT in days with respect to % removal efficiency of COD with an average influent COD of 489 mg/l

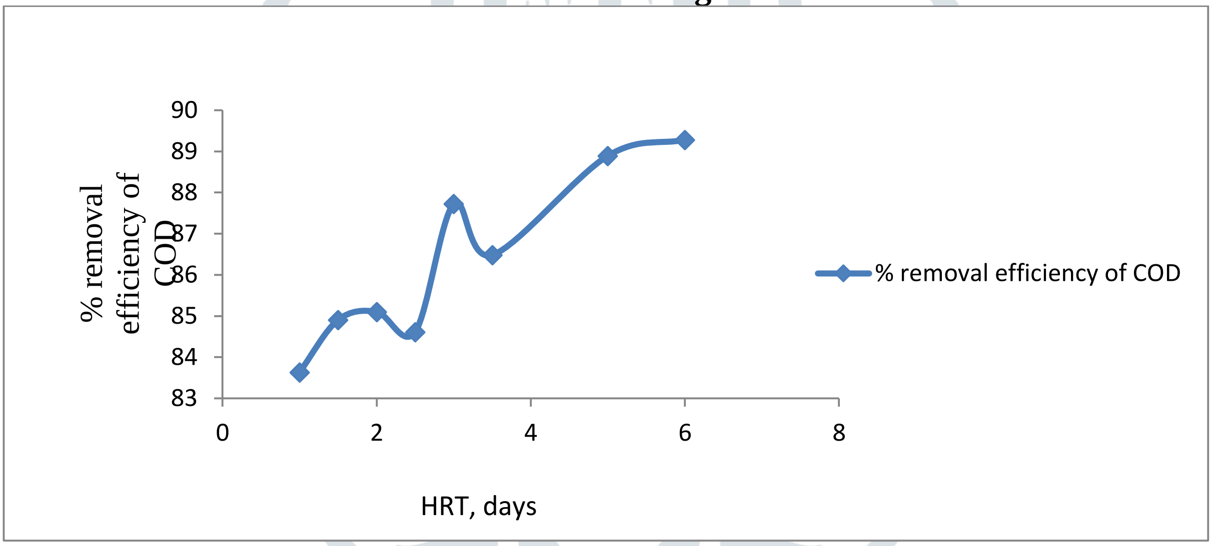

Figure 3. HRT in days with respect to % removal efficiency of COD with an average influent COD of 356 mg/l

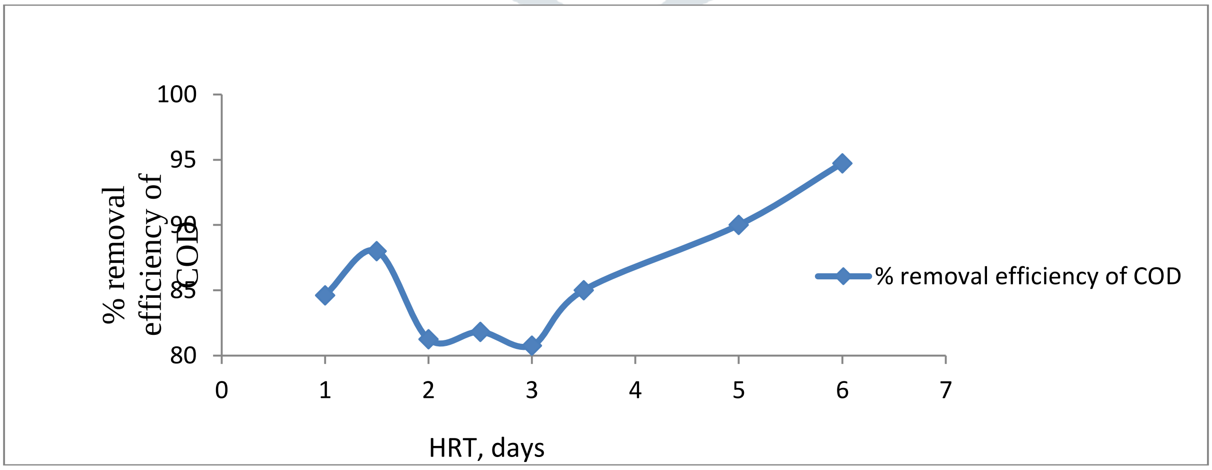

Figure 4. HRT in days with respect to % removal efficiency of COD with an average influent COD of 190 mg/l

The OLR of this study was from 0.026 to 0.649 Kg COD/ m^3.days. The COD removal efficiency for the final set of experiment was achieved 94.73% with an Influent COD of 489 mg/l decreased to 190 mg/l. The Dissolved oxygen attained the maximum of 8.7 mg/l at an OLR of 0.236 Kg COD/m^3.day, and the minimum 3.1 mg/l was obtained at OLR of 0.058 Kg COD/m^3.day as shown in Figure 5, 6 and 7.

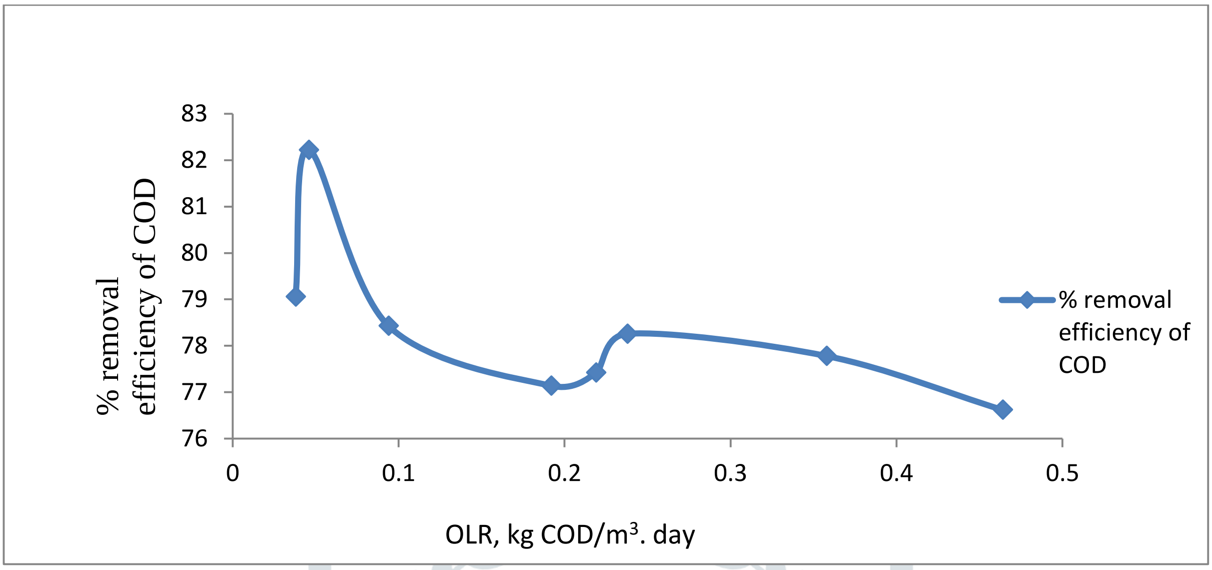

Figure 5. OLR, kg COD/m^3. day with respect to % removal efficiency of COD with an average influent COD of 489 mg/l

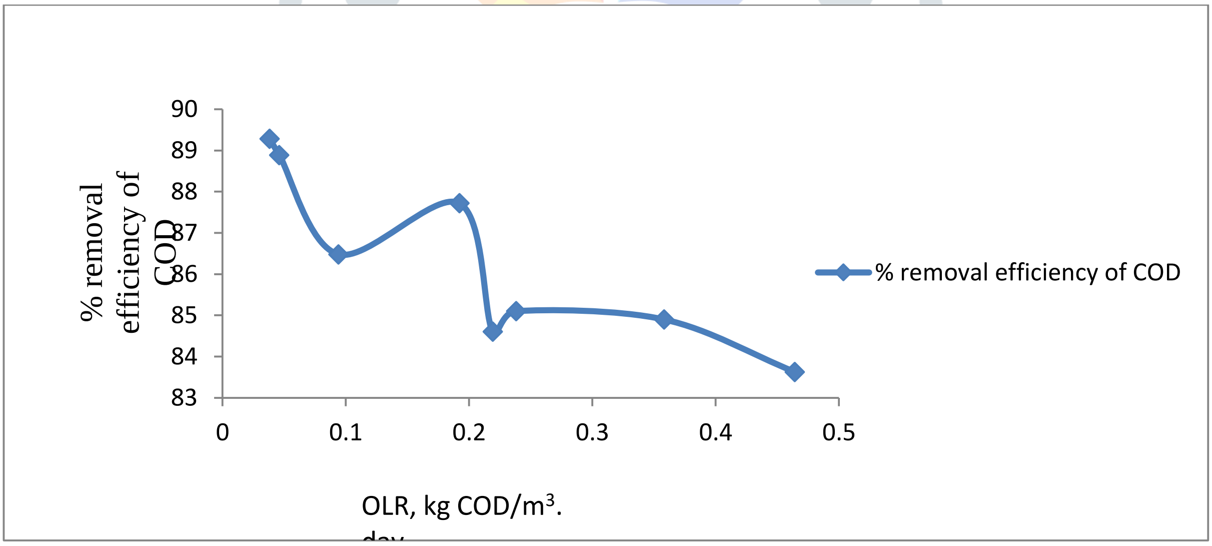

Figure 6. OLR, kg COD/m^3. day with respect to % removal efficiency of COD with an average influent COD of 356 mg/l

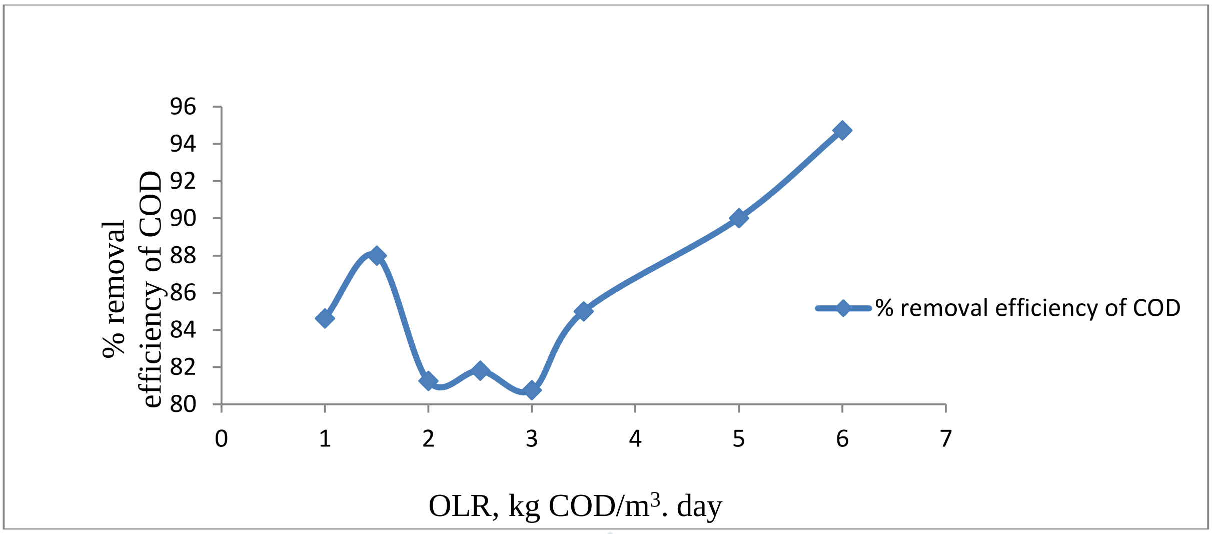

Figure 7. OLR, kg COD/m^3. day with respect to % removal efficiency of COD with an average influent COD of 190 mg/l

4. CONCLUSION

From the results of present study it was concluded that *Azolla* served as a perfect sorbent for treating the institutional wastewater. *Azolla* was more efficient for reducing almost all the parameters studied. It has been observed that phytoremediation of wastewater using the floating plant system is a predominant method which is economic to construct requires little maintenance and increase the biodiversity. The maximum removal efficiency of COD was attained 94.73% using azolla as a sorbent at a HRT of 5 days with an OLR of 0.026 kg COD/m^3. Day Dissolved oxygen of this research work was with in the standard limit. Hence the treated effluent can be reused for irrigation purpose.

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