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Removal of Various Pollutants from Grey Waste Water using Canna Lily Plants: A Concise Review

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Abstract: ***Grey Waste Water has become a serious challenge in most of urban as well as rural areas of various developing countries. Grey waste water, instead of allowing it to flow into sewer system, it can be recycled and reuse . The recycling can be done using a Constructed Wetland (CW) cell supporting a full developed layer of Canna Lily plants. This plant use phytoremediation to help in the removal of the nutrient. Canna lily is mostly suitable for Tropical and Sub tropical conditions. Treatment of grey waste water with canna lily plants gives removal of high strength of Carbon, Nitrogen, Phosphate (CNP) . Total dissolved solid removal efficiency is also high . BOD_5 and COD removal rate is more than 50%. The high removal rate for Nitrate and Phosphate suggest for a possible use of canna lily plant based constructed wetland for treatment of grey waste water in small rural and remoSte areas.***

Keywords: Canna lily, Constructed wetlands, CNP, Grey waste water, Phytoremediation.

I. INTRODUCTION

Increasing stress on the fresh water availability has led the idea to develop wastewater recycling .The waste water particularly coming from households has greater potential than any other sources. The households has generally two types of waste water Grey waste water and black waste water .black waste water is waste coming from toilets. Grey waste water includes wastes generated from bathroom sinks, kitchens, baths or shower, washing clothes except the waste water from toilets. Grey waste water treatment and reuse is one of the efficient solution which offer the largest potential of water savings. Moreover, greywater is lightly polluted and requires less expensive treatment prior to non potable reuse [7].

Cost-effective treatment of grey waste water has become a serious challenge in most of the cities of the world. Urban sprawl has resulted in increased impervious surfaces like roads, rooftops, parking spaces etc. leading to higher surface runoff and mobilization of pollutants[4]. Constructed wetlands (CWs) are reported to be inexpensive and promising tool for nutrient removal and stabilization of grey wastewater with very low energy input rates . Constructed Wetlands have also been claimed to reduce BOD_5 for unrestricted urban use . There is significant decrease in BOD_5 during conventional secondary treatment of grey wastewater, but the removal of nitrogen and phosphate remains limited[4]. The role of macrophytes in grey waste water treatment and removal of pollutants tolerance to water stress and chemical fluctuations, making it a suitable candidate for phytoremediation. Canna lily plants, an extensively studied potential plant for grey wastewater treatment in CWs. Apart from it, the aesthetically pleasing look ,and floriculture possibility adds a new dimension to its use in constructed wetlands.

A study by Belmont and Metcalfe (2003) reported that Canna lily, has limited growth and cannot survive in cold winter in northern hemisphere (under temperate conditions) and therefore has a limited use in CWs in such countries. On the other hand, its use in tropical and subtropical countries is expected to yield better results and it can complement the deficient removal rates of conventional treatment systems[2].

II. STUDY OF METHODOLOGY

A. Constructed Wetlands

Constructed wetlands treat the grey waste water using highly effective and ecologically sound, design principles that use plants, microbes, sunlight and gravity to transform wastewater into gardens and reusable water. The water treatment mechanisms are biological, chemical and physical, these include physical filtration and sedimentation, biological uptake, transformation of nutrients by bacteria that are anaerobic (bacteria that flourish in the absence of oxygen) and aerobic (oxygen-needing bacteria), plant roots and metabolism, as well as chemical processes (precipitation, absorption and decomposition) that purify and treat the grey wastewater. While the system does not normally use machinery (except pumps if necessary to get wastewater to the CW unit/s against gravity), nor any chemicals, the variety of natural mechanisms that do the water recycling and purification make Constructed wetlands very effective.

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Constructed wetland treatment systems use rooted wetland plants and shallow, flooded or saturated soil to provide wastewater treatment. Constructed wetlands are designed to take advantage of the chemical and biological processes of natural wetlands to remove contaminants from the grey wastewater. Studies have provided evidence that wetlands systems can effectively improve water quality . Wetlands remove metals using different processes. Metal removal rates in both subsurface flow and surface flow wetlands can be high, but can vary greatly depending upon the influent concentrations and the mass-loading rate.

Fig. 1 Constructed Wetland (source by:-environmental expert.com)

B. Canna Lily Plants

Canna lily is a ornamental flowering species, having a scientific name of Canna Indica. It is commonly known as keli is widely cultivated throughout India ,tropical and sub tropical countries. Canna lily is known as phytoremedation plant and had a flourishing root system with higher root growth, higher root number, larger root biomass and significantly larger root surface area than the other plant species. This plant has great tolerance to the pollutants and has long root life span.

The roots of canna plant supplies abundant amount of oxygen, the bacteria present in the soil becomes active and due to this abundant amount of oxygen available the sludge digestion takes place for long period. As a result, the organic and inorganic compounds in the grey waste water are taken as a food by the Aerobic bacteria and renders the grey waste water clean. At the lower level of soil layer Anaerobic bacteria are present which digests the remaining waste or sludge in the grey waste water which is left over from the Aerobic bacteria. As the Anaerobic bacteria digests the waste left over by the Aerobic bacteria and consumes this waste as food and clean the grey waste water

Fig -2 Canna lily plants in constructed wetlands.(source:- H D Tran *et.a.l.*)

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III. MATERIAL AND METHOD

A. Wetland Configuration

A bench scale CW cell around minimum (1.1 m length × 0.8 m breadth ×0.35 m depth) should be used during the study[6]. The CW cell should located outdoors in a semi-arid climate with no protection from temperature, sunlight, rainfall and evapotranspiration to study the removal under natural conditions. The inlet and outlet valves must be provided to feed raw water and collect the outflow, respectively .

The cell packed with sand gravel bed to a depth of 0.25 m and a space of 10 cm over it. The size characterization of sand-gravel packing medium representing the graded soil profile with voids in between to facilitate easy root penetration throughout the treatment CW cell.

A slope of 10mm provided along the length to facilitate flow. Around 50 plants of Canna lily with mean shoot length must be grown in the wetland cell and an initial period of 15 days must be there to let the plant stabilize in CW cell before undertaking the removal studies[6].

B. Sample Collection and Analysis

After an initial period of 15 days for stabilization of Canna lily plants in wetland cell, grey waste water get fed to the system with a total volume of 150 litres initially.

Later, 15 litres of grey wastewater must be added to the system on regular intervals of 24 hours to make up for the nutrients and evapotranspiration losses. The sample of treated wastewater must be regularly collected from the outlet and analyzed . The analysis of the treated wastewater should be done as per the standard methods[6].

IV. RESULTS

On reviewing different research papers, the removal of different parameters and nutrients is summarized as follows.

A. Removal Of Dissolved Solids

The nutrient removal from grey waste water depend on the water uptake of plants. Canna lily has a water demand of the order of 1.4litres/plant/day [3] as studied in sub tropical regions . This demand is 3-5 times more than the other wetland vegetation. The higher the temperature , higher is uptake of water and so is the removal of dissolved nutrients.

On comparing the level of inlet and outlet dissolved solids, percentage removal of dissolved solids varies from 63.2 to 74.1 with an average value of 67.85%[6].

B. Removal Of Organic Carbon

The Organic carbon in grey wastewater gets monitored in terms of BOD_3 and COD. The percent removal ranged from 69.8 to 96.4 with an average value of 87.3% [6]. The Percent removal of COD ranged from 63.6-99.1%, with average of 92.8%[6].The removal efficiency of canna lily for BOD_3 and COD has higher efficiency against the removal efficiency of Typha latifolia and Ipomes spp. based wetland system.

C. Removal Of Nitrogen

Total nitrogen in grey wastewater being measured as the sum of Total Kjeldahl's Nitrogen (TKN) and nitrate. Concentration of nitrite should not be determined since it remains very low and insignificant compared to that of ammonium and nitrate in treatment wetlands. The percentage removal varied from 69% to 94% with an average value of 89%[6]. Good removal efficiency for TKN suggests significant nitrification rate facilitating conversion of ammonium ions to nitrate, and subsequent removal of nitrogen. Generally, reduction in concentration of TKN is observed slightly higher than that of nitrate since plant assimilation as well as nitrification of ammonium to nitrate account for TKN removal, whereas removal of nitrate takes place by plant assimilation alone[3].

D. Removal Of Phosphate

Phosphate in wastewater was measured as available phosphate (orthophospahte). The percentage removal varied from 77.3 to 91.6% with an average of 82.6% [6].The major removal mechanisms of phosphate might be uptake by plants and adsorption by antecedent substrate like soil and sediments. Higher removal rates of available phosphate may also be attributed to higher uptake by canna lily plants during the intial growth phase before maximum growth is attained.

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V. CONCLUSION

The conclusion of the following study is :-

Removal of nutrients (CNP) from wastewater by Constructed Wetlands is found to be potentially effective. Significantly high removal efficiency of Constructed wetlands stresses upon the use of such unconventional methods in high-strength- grey wastewater treatment particularly under tropical conditions[6]. Grey domestic wastewater treated naturally by using Canna plants and natural soil can be used for treating the residential grey water instead of treating the grey water by using treatment plants, as it shows decreased composition of organic and inorganic compounds which is completely safe for the domestic re-usage such as gardening, flushing of toilets as per the water quality standards for domestic usage. This type of treatment which is done at low cost will be very economical and safe for re-usage for domestic purpose and this process can reduce 50 to 60% of fresh water usage and maintains good water level in the ground water table around the surrounding and reduces water scarcity problems. Requirement of large areas and nuisance can be drawback of this removal technique .Their can be difference in BOD_5 removal efficiency due to different nutrients present in grey waste water of different localities.

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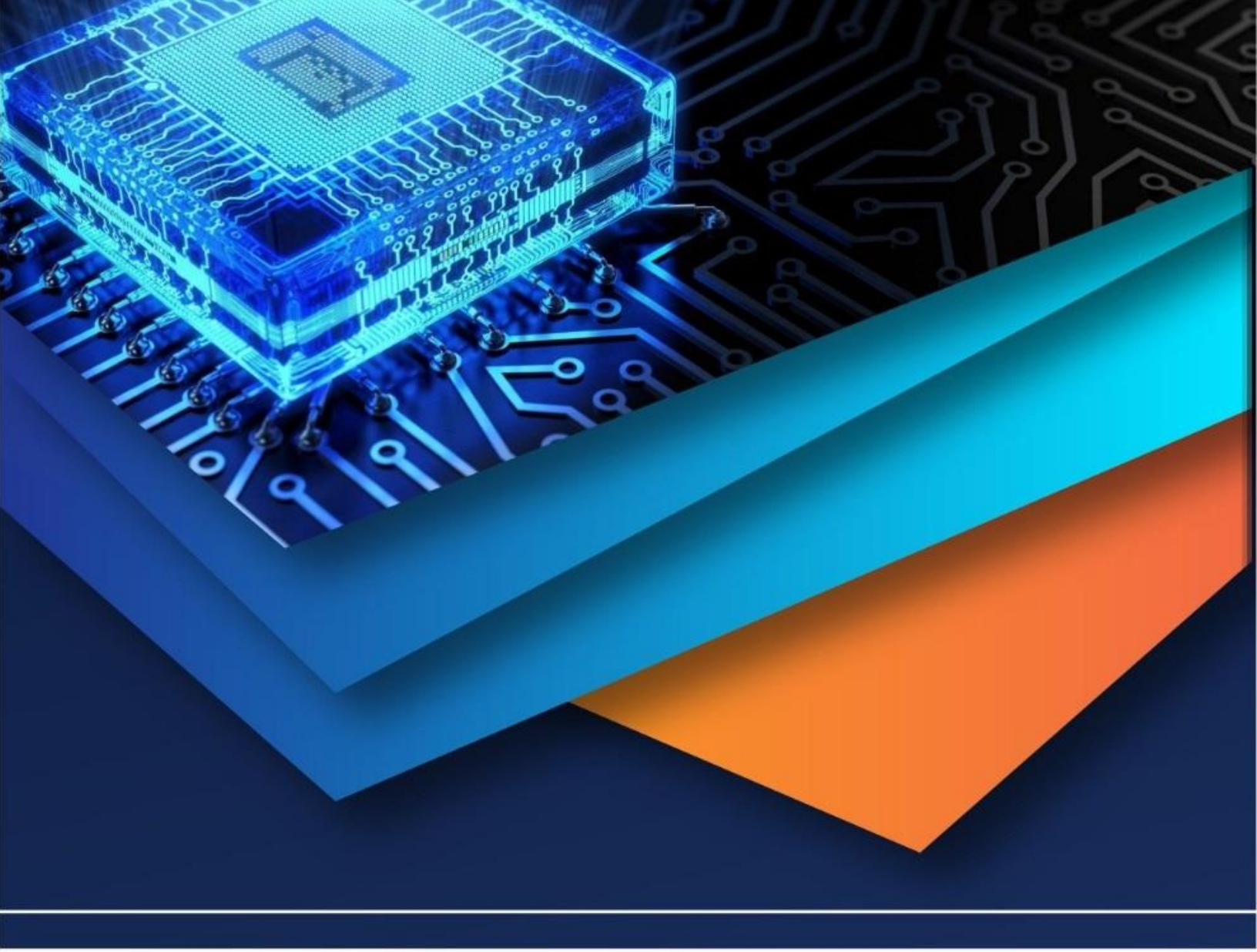

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