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Lake Water Treatment Using Locally Available Natural Submerged Aquatic Plants

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Abstract: Increasing urbanization, industrialization and over population are the factors mainly responsible for adding hazardous components in lake water, which mainly constitutes heavy metals and chemicals etc. Water bodies are the main targets for disposing the pollutants directly or indirectly. In this project illustrating the role of plants to assist the treatment of wastewater. The prevailing purification technologies used to remove the contaminants are too costly and sometimes non-ecofriendly also. Therefore, the research is oriented towards low cost and eco-friendly technology for waste water purification, which will be beneficial for community. The project discusses the potential of different process and utilization of terrestrial and submerged aquatic plants (Hydrilla) in purifying water and wastewater from different sources. Present study was conducted by off-site experiment, where Hydrilla verticillata Casp was cultured in a tub for subsequent seven days over one year. Second one of the tub was used as control. The quality of domestic wastewater was assessed before and after the experiment by analyzing physicochemical parameters. . The results of the present experiment revealed the significant improvement in the quality of municipal wastewater, as indicated by the decrease in values of most physicochemical parameters studied. That showed efficiency and potentiality of aquatic plant for the purpose.
Keywords: Wastewater Treatment, Submerged Aquatic Plants, Lake Water, Constructed Wetlands, Hydrilla

I. INTRODUCTION

Earth is covered by almost 70% water. Fresh-water content of this total available water of the earth is only 3% which comprises of icecaps, glaciers, groundwater and surface water. Only 0.3% of this surface water is available for human use like agriculture, household and drinking, industry, etc. in the form of lakes, swamps and rivers. Modern technology, global industrialization and unhygienic lifestyle have lead to a serious problem of pollution in freshwater resources like lakes, rivers and swamps . Industrial effluents contribute to the inorganic pollution due to addition of waste chemicals. Anthropological influences like domestic liquid discharge, agricultural wastes, organic industrial wastes, etc. provides adequate nutrients in dissolved state for growth of pathogenic bacteria, and algae and also which interferes in beneficiary use of these natural supplies of freshwater. Rivers, lakes and other freshwater bodies encounter a serious environmental problem of eutrophication due to excess deposition of phosphorus deduced from various human activities. Pharmaceutical industry effluents add up to the existing contamination of freshwater bodies which can cause acute water pollution and other environmental hazards.Aquatic plants have been used to recover and recycle these waste waters and use them for agricultural and industrial purpose if not for household and domestic use. Low cost, easy maintenance and the ability to assimilate nutrients and sediment the inorganic chemicals makes the aquatic plant system a promising domestic prospect for waste water management . Though there are ponds built with aquatic plant system for treatment of municipal and industrial waste water, the main challenge lies in availability of large lands, authenticity of removal of pathogenic bacteria by the aquatic plants and the choice of aquatic plants. Water hyacinth and dry hyacinth are already used for this purpose in the tropical areas. Macrophytes plays prominent role in recycling or removal of heavy metal contaminants and microbes . Surface floating plants uptake heavy metal through their roots whereas leaves as well as roots of submerged plants participate in this phenomenon. The emergent plants or macrophytes influence metal storage indirectly by modifying the substratum through oxygenation, buffering pH and adding organic matter It has been reported earlier that almost 78% to 91% removal of BOD, reduction of nitrogen from 30.8 to 9.8 mg/l and phosphate from 14.9 to 9.6 mg/l were observed using emergent macrophytes Typha latiofolia and Phragmites carka . It is reported that Hydrilla sp. has better removal efficiency when compared to Salvinia sp. and is an excellent biosorbent for treating waste water contaminated with low concentration of cadmium . There are many other potential aquatic plants which can be used in this respect but lack of investigation and reports in their support have not allowed doing so. Hydrilla is a perennial submerged plant that has been used as an animal feed, decorate aquariums and has been reported as an efficient agent for removal of dissolved nitrogen and phosphorus.

Aquatic plant system has been accounted asone of the processes for wastewater recovery andrecycling. The main purposes of using this systemhave focused on waste stabilization and nutrientremoval. The principal removal mechanisms are
physical sedimentation and bacterial metabolicactivity as in the conventional activated sludge andtrickling filter (USEPA, 1991). Plant assimilationof nutrients and its subsequent harvesting areanother mechanism for pollutant removal. Lowcost and easy maintenance make the aquatic plantsystem attractive to use. Thus, constructed pondswith aquatic plants are increasingly applied as aviable treatment for municipal wastewater. However, there are some constraints with using aquatic plants such as the requirement for large area of land, the reliability for pathogen destruction, and the types and end-uses of aquatic plants.Submerged Aquatic Plants are oxygenating plants. Plants like hydrilla increase the oxygen content of water and remove carbon dioxide from it Plants also gives enough oxygen for aquatic animals. This leaves have no pores and stomata that’s why these plants absorb more carbon dioxide from water and in simple word it will create the process of Rhizofiltration. We all are know so many toxic metals and other components are present in lake water so due to the process of Rhizofiltration, this plants easily remove toxic metals and unwanted components from water. We also know about it many peoples are washing their clothes, vehicles, buffalos, cows, etc and so many peoples are bath in lakes and because of bad human activities like release wastewater into lake, release industrial waste water etc. such activities dirt the lake water. So by using submerged aquatic plants we wants to remove toxic substances from water and we will try to make water fresh for use.

A. Common Submerged Aquatic Plants:

Muskgrass (Chara spp.) is actually a form of erect algae. It is a great plant for ponds with excessive nutrients because it uses up a large amount of nutrients and provides food and hiding for fish and other organisms. It can look like several other aquatic plants, but a way to tell it apart is to break the thin straw-like stem. Since it is a single celled stem, if you break it, the entire stem will turn flaccid. Other plants will just break or bend, not turn flaccid. Also has a strong garlic smell to it. As with many plants, it is good in moderation. The pond above is a bit over grown.

Pondweed (Potamogeton) is a thin leafed aquatic plant that is native to many areas. This plant can serve as a food source and hiding place for organisms in your pond and produce oxygen. Since it is native, it is not as invasive as non native plants, but it must be kept in moderation. This picture is of young pondweed before it puts out is surface leaves. Some consider pondweed as a floating plant due to these surface leaves.

Eurasian Watermilfoil (Myriophyllum spicatum) is not native to the US and is an extremely invasive species. There are strict regulations for boats in lakes that contain eurasian watermilfoil because small pieces that break off can stick to boats and trailers and then re-root in other bodies of water. The leaves are feather-like and are limp when out of water. The leaves are arranged in circles of 3 to 5 around a long, spaghetti stem. The plants can grow over 10′ tall. The tops of the stems often are reddish in color.

Bladderwort (Utricularia purpurea) is an aquatic plant that can live in ponds with limited nutrients available. It is actually a carnivorous plant. It can look like an unorganized mess in your pond, but it eventually comes together to form the “starfish” shape and then shoots up the yellow flowers. Black bladders hang below that open and catch small organisms like zooplankton. Bladderwort can be a pain if it takes over your pond and since it isn’t as dependent on nutrients in the pond, it can spread rapidly.

Hydrilla (Hydrilla verticillata) is an undesirable aquatic plant with long, branching stems. Hydrilla often fragments and form large floating mats. It produces tiny white flowers in early fall. It can be differentiated from Elodea or Egeria with its sharp toothed leaf margins. Hydrilla feels brittle to the touch. Hydrilla can grow in shallow or deep water and can quickly spread throughout a body of water. – photo courtesy of The Lake Doctors, Inc.

Common Waterweed (Egeria densa) is branched and has a long, narrow stem with dense leaves found in whorls of 4. The leaves can be oblong or linear and are very fine toothed. It produces flowers that are white with yellow anthers. As with many aquatic weeds, it needs to be controlled to prevent overtaking your pond. – photo courtesy of The Lake Doctors, Inc.

Elodea (Elodea canadensis) is commonly confused for hydrilla or egeria, but is much smaller in size. The leaves are bright green, in whorls of 3, and elliptic to oblong. Small white flowers are produced from mid summer to fall. Needs to be kept in check to limit spreading. – photo courtesy of The Lake Doctors, Inc.

Coontail (Ceratophyllumdemersum) is a submersed aquatic plant, but does not have any root structure. The feathery, fan shaped leaves are arranged in whorls with small teeth and resembles a raccoon tail. Coontail can grow very tall (15′) and occur in deep water areas. Controlling the spread of coontail can be difficult since it is free floating. – photo courtesy of The Lake Doctors, Inc.

II. SCOPE & OBJECTIVE

- To evaluate the effectiveness and potential of Hydrilla verticillata Casp (a submerged aquatic plant of family hydrocharitaceae), in removing nutrients from domestic wastewater.
- To examine the Hydrilla plant ability to remove the physical, chemical wastewater parameters from lake water.
- To study different case studies related to constructed wetlands helps to understand the importance of aquatic plants.

III. LITERATURE REVIEW

The scientific studies on the use of CWs for wastewater treatment began in the middle of the last century. The first experiments were undertaken by Käthe Seidel in Germany in the early 1950s at the Max Planck Institute in Plön(Seidel, 1955). In her report, she discussed the possibility “of lessening the overfertilization, pollution and silting up of inland waters through appropriate plants, thereby allowing the contaminated waters to support life once more” (Seidel, Happel, & Graue, 1978, p. 2). She opines that macrophytes (e.g., Schoenoplectuslacustris) are capable of removing large quantities of organic and inorganic substances from polluted water. Moreover, Schoenoplectus spp. (bulrush) not only enriches the soil on which it grows in bacteria and humus but apparently exudes antibiotics. Bacteria and heavy metals in the polluted water are eliminated and removed by passing through the macrophytes.Seidel’s discoveries gave birth to modern CWs and stimulated the following research and applications of engineered treatment wetlands in the Western world. However, most of her studies focused on the subsurface flow (SSF) CW. The first fullscale CW was built with a FWS system in the Netherlands in 1967 (De Jong, 1976). This treatment facility was designed to clean the wastewater from a camping site with 6000 summer visitors per day.In North American, the experimentation with FWS wetlands started with the observation of assimilative capacity in natural wetlands at the end of the 1960s and beginning of 1970s (Spangler, Sloey, & Fetter, 1976; Wolverton, 1987). Between 1967 and 1972, researchers in Chapel Hill, North Carolina began a five year study using a combination of constructed coastal ponds and natural salt marshes for the recycling and reuse of municipal wastewater (Odum, Ewel, Mitsch, & Ordway, 1977). In 1973, the first fully CW consisting of a series of constructed marshes, ponds and meadows was built in Brookhaven, New York (Kadlec & Knight, 1996). About the same time, an interdisciplinary research team at the University of Michigan began the Houghton Lake project. This is the first application of a treatment wetland in a cold climate area (Kadlec, Richardson, & Kadlec, 1975; Kadlec & Tilton, 1979). Since then, FWS CWs have been broadly used in the United States for various types of wastewater treatment.

ATIF MUSTAFA(2013) conducted treatment performance of a pilot-scale constructed wetland (CW) commissioned in in Karachi, NED University of Engineering & Technology, was evaluated for removal efficiency of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), ammonia-nitrogen (NH_4-N), ortho-phosphate (PO_4-P), total coliforms (TC) and faecal coliforms (FC) from pretreated domestic wastewater. Monitoring of wetland influent and effluent was carried out for a period of 8 months. NED wastewater treatment plant (WWTP) treats wastewater from campus and staff colony. The wastewater contains domestic sewage and low flows from laboratories of various university departments. The constructed wetland is planted with common wetland plant (*Phragmites karka*). The key features of this CW are horizontal surface flow. Treatment effectiveness was evaluatedwhich indicated good mean removal efficiencies; BOD (50%),COD (44%), TSS (78%), NH4-N (49%), PO4-P (52%), TC (93%)and FC (98%).

YADAV and JADHAV (2011) construct wetland unit combined with surface flow and planted with *Eichhornia crassipes* was built near Technology Department, Shivaji University, Kolhapur (Latitude 160 40’ N, Longitude 740 15’ S). Maharashtra situated in Western part of India. The campus wastewater was let into the constructed wetland intermittently over 30 days.The study was performed in two sets A and B which were run in the months of December and January respectively. The parameters analysed for the study were pH, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Nitrogen and Phosphorus. Only quality of wastewater was analysed during the study period of 2 months i.e. December and January. The sampling took place daily at both inlet and outlet of constructed wetland system. Treatment effectiveness was evaluatedwhich indicated good mean removal efficiencies; BOD (95%),COD (97%), TSS (82%), NH4-N (43%), PO4-P (49%).

Raw sewage consists of a combination of domestic and commercial wastewaters. The pollutant parameters commonly present are BOD, TSS, organic compounds, pathogens, nutrients (especially nitrogen) and heavy metals. CWs are very efficient in reducing the level of these pollutants in municipal wastewater effluents. In FWS wetlands, the removal mechanisms include flocculation, sedimentation, absorption, oxidation and anaerobic reaction.

In a properly operating CW system, the concentration of in the effluent should be less than 30mg/L, TSS are less than 25 mg/L, and fecal coliform bacteria concentration is less than 10,000 colony-forming units (cfu)/100 mL (David, James, Christopherson, & Axler, 2002)

Biochemical Oxygen Demand (BOD5) Removal. BOD5 is a measure of the mass of oxygen required by aerobic organisms to decompose organic matter in the water. The standard BOD value is commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20 °C. In FWS wetlands, removal of the soluble BOD5 is due to microbial growth attached to plant roots, stems, and leaf litter that have fallen into the water. Because algae are not present with the complete plant coverage, water surface reaeration provides the major sources of oxygen for these reactions in addition to plant translocation of oxygen from the leaves to the rhizosphere (U.S. EPA, 1980). BOD5 removal often approximates first-order kinetics. Based on the First Order–Reaction Kinetics–Plug Flow Approach, Reed´s method is used to estimate BOD removal efficiency. This method is a research-based design method based on the firstorder plug flow assumption for those pollutants that are removed primarily via biological processes (i.e., BOD, ammonia, and nitrate) (Knight, Ruble, Kadlec, & Reed, 1993).

TSS Removal. The “total solid” refers to the suspended or dissolved matter. TSS are solids that can be retained by a filter. The removal of TSS from water to the wetland sediment bed is essential for both the improvement of water quality and the function of the wetland ecosystem. TSS are predominantly removed via flocculation/sedimentation and filtration/interception mechanisms (U.S. EPA, 1999). Suspended solids can also be produced within the wetland. This occurs due to the death of invertebrates, fragmentation of detritus from plants, production of plankton and microbes within the water column or attached to plant surfaces, and formation of chemical precipitates. TSS removal processes are related to filtration and retention times. The slow flowing water allows the physical separation of TSS.

Nitrogen Removal. Nitrogen is a serious concern in wastewater because of its role in eutrophication and toxicity to aquatic. Numerous biological and physiochemical processes in wetlands are particularly important in the transformations of nitrogen into varying biologically useful forms. Additionally, plants that require nitrogen for their growth play an active role in removing it from the wastewater. Nitrogen removal occurs through nitrification, denitrification, ammonification, volatilization and plant uptake . The removal rate in a wetland is 61% through denitrification and 14% through plant biomass, and the remainder is stored in the soil (Matheson, Nguyen, Cooper, Burt, & Bull, 2002). Hence, the nitrification and denitrification processes occurring within the wetland are the major mechanisms for nitrogen removal (Vymazal, Brix, Cooper, Green, & Haberl, 1998). Vegetated zones are anaerobic, because oxygen released by hydrophytic plants is trivial compared to the oxygen demands. Therefore, nitrification unlikely to happen in VSB wetlands and highly dense vegetated zones of FWS wetlands, but can be accomplished in open-water zones. To increase the efficiency of nitrification and denitrification, a well aerated condition must be followed by the vegetated zones.

Total Phosphorus Removal. Phosphorus is one of the important nutrients that cause eutrophication in the lakes. Plants uptake phosphorus during the growing season, but the phosphorus is released back into the water during decomposition when plants die. Phosphorus can also be released in varying proportions at different times throughout the year and is cycled throughout the wetland. The predominant form is orthophosphate which can be used by algae and macrophytes. Inorganic phosphorus can also be found as polyphosphates. Municipal wastewaters may contain from 5 to 20 mg/L of total phosphorous, of which 1 to 5 mg/L is organic and the rest is inorganic. The per capita phosphorous contribution per inhabitant per day averages about 0.0048 lb/person/day (Kentucky Department of Environmental Protection, 2012). The removal of phosphorus in wetlands is achieved through physical, chemical, and biological processes (Debusk, 1999). The physical process includes sedimentation and entrapment within the emergent macrophyte stems and attachment to plant biofilms. Chemical methods are soil absorption and desorption. This involves soluble inorganic phosphorus moving from the pores in the soil media to the soil surface. The biological mechanism involves uptake of phosphates by microorganisms, including bacteria, fungi, and algae. The biological process is rapid but does not allow for much storage. In FWS wetlands the uptake from free floating macrophytes is more important but these plants must be harvested and replaced to maximize phosphorus removal. Typical phosphorus removal is in the 40% to 60% range (Vymazal, 2006).

IV. PROBLEMS STATEMENT

The Futala lake water is unpotable and now–a-days used for irrigation purpose and for commercial fisheries. It doesn’t have self cleaning capacity; hence continuous addition of nutrients through many polluting sources is leading. The watershed of Futala lake is a part of Nag river watershed. Nag River is completely polluted on account of incoming sewage into it. The Four streams are prominent within catchment. The Futala Lake and its environs near Telankhedi Garden on Amravati road, Nagpur, is a picnic spot. It is rainwater impoundment with an area of 26.3 hectors and 5-6 meters deep during monsoon. Futala Lake, too, is facing the threat of eutrophication with weeds covering almost half the lake area already.

The sewage is released into Futala Lake without treatment therefore the Futala lake water is polluted at moderate level. In Futala Lake, eutrophication was first seen in some portion towards west, but, almost half of the lake area is covered by weeds, especially on south and north side. Species inside the water start to diminish due to lack of sunlight, even oxygen level in lake water already drastically dropped. Another worry for the lake was, collapse of large portion of embankment towards the bund embankment, constructed with black stone in some time ago, raising the needs for inspection of remaining portion of the embankment. Futala Lake was chosen in this study, since it is heavily influence by human actions leading to domestic and partially agricultural pollution sources. The basic objective of present study is to treatment of Futala lake water using submerged aquatic plants.

V. PROPOSED METHODOLOGY

A. SAMPLING LOCATIONS

According to a survey by ABP News-Ipsos, Nagpur has been identified as the best city in India by topping the liveability, greenery, public transport, and health care indices. It is famous for the Nagpur Orange and is known as the “Orange City” for being a major trade center of oranges cultivated in the region.Nagpur city with coordinates of 21º8'55" and 79º4'46"E is second capital of Maharashtra state. Nagpur city is popularly known as orange city, also city of lakes. The city had 10 lakes in the past, but unfortunately only 7 of them are there now. The Futala Lake with a coordinate of 21º8`44``N and 79º03` 48``E is closed water body. The Fulata lake is spread over 60 acres. The Futala Lake is located at the western side of the Nagpur city. The catchment area of dam is 6.475 sq. km. The length of west weir is 8.0m. Futala lake is having capacity to irrigate an area of 34.42 hectors of cultivated agriculture land and Telenkhedi Garden. The initial purpose for irrigating nearby agricultural land was prominent amongst the utilization of Futala lake.

(Figure4.1: Satellite Image of Futala Lake)

B. U.S. EPA Guidelines

There are no federal regulations governing reclaimed water use, but the U.S. EPA (2004b) has established guidelines to encourage states to develop their own regulations. The primary purpose of federal guidelines and state regulations is to protect human health and water quality. To reduce disease risks to acceptable levels, reclaimed water must meet certain disinfection standards by either reducing the concentrations of constituents that may affect public health and/or limiting human contact with reclaimed water.

Based on the U.S. EPA inventory, current regulations can be divided into the following reuse categories: unrestricted urban reuse (irrigation of areas with unrestricted public access), restricted urban reuse (irrigation of areas with controllable access), agricultural reuse on food crops, agricultural reuse on non-food crops, unrestricted recreational reuse, restricted recreational reuse, environmental reuse (wetland or sustain stream flows), industrial reuse, groundwater recharge, and indirect potable reuse. Based on the study objectives, the regulations on “unrestricted urban reuse” and “agricultural reuse on food crops” should be considered in this research. Table 1 lists the U.S. EPA guidelines for urban reuse and agricultural reuse water quality.

Table 4.1 U.S. EPA Guidelines for Water Reuse

Urban reuse (landscape irrigation, vehicle washing, fire protection, commercial air conditioners, etc.)	Secondary Filtration Disinfection	pH=6-9, BOD≤10mg/L, ≤2 NTU, No detectable fecal coli/100mL, 1 mg/L CL2 residual(minimum)	50 feet to potable water wells	pH: weekly, BOD: weekly, Turbidity: continuous, Coliform: daily, Cl2 residualcontinuous
Agricultural reuse on food crop	Secondary Disinfection	pH=6-9, BOD ≤30mg/L, TSS ≤30mg/L, < 200 fecal coli/100ml, 1mg/L CL2 residual(minimum)	300 feet to potable water wells 100 feet to areas accessible to the public (if spray irrigation)	pH: weekly, BOD: weekly, TSS: daily, Coliform: daily, Cl2 residualcontinuous
Agricultural reuse nonfood crop	Secondary Filtration Disinfection	pH=6-9, BOD≤10mg/L, ≤2 NTU, No detectable fecal coli/100mL, 1 mg/L CL2 residual(minimum)	50 ft (15 m) to potable water wells	pH: weekly, BOD: weekly, Turbidity: continuous, Coliform: daily, Cl2 residualcontinuous

C. MATERIALS AND METHODS

1) Materials

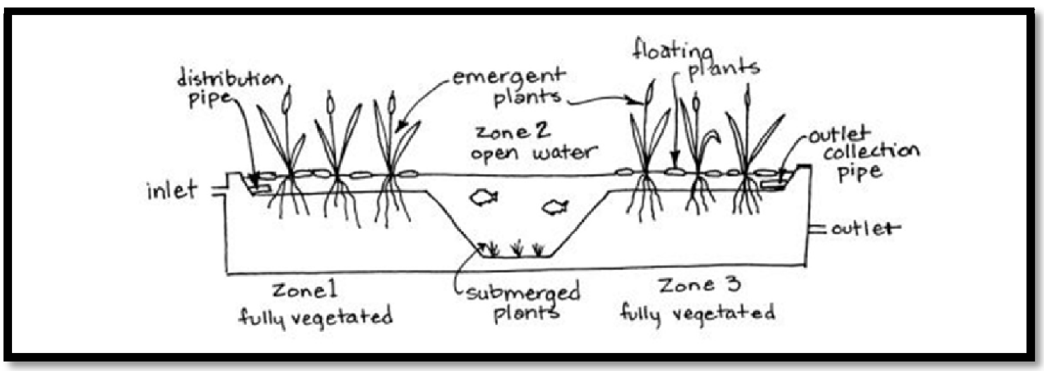
- Submerged Aquatic Plants (Hydrilla)
- Wastewater Sample
- Tube
- PVC Pipe
- Valve

(Figure4.2: Collection of Submerged Aquatic plants)

(Figure4.3: Wastewater Sample and Hydrilla plants)

2) Experimental technique

Experimental aquatic plant (Hydrilla verticillata Casp.) is a submerged aquatic plant, native of Africa, Australia and parts of Asia, which can quickly overcome other plant species because of the ability to grow with less light and more efficiently take-up nutrients from aquatic system. Remediation of nutrients from lake water (wastewater) was studied by using a Hydrilla verticillata Casp. A fixed amount of 100gms of this aquatic plant was cultured in a plastic tub of 0.173 m diameter, six inches deep and 20 Liter capacities containing domestic wastewater, for a week interval.



(Figure4.4: Constructed Wetland Process)

3) Rhizofiltration Technique

A rhizofiltration system planted with Hydrilla was constructed with the sample of Futala lake Nagpur, Maharashtra, and evaluated for its efficiency in removing physical, chemical parameters and enteric pathogens from wastewater.The utilisation of wetlands for remediation of polluted soils and waters via rhizofiltration, phytostabilisation and phytoextraction has been increasing steadily over the past decades. The use of wetlands for quality improvement of wastewater, referred to as rhizofiltration, is the best known and most researched application of constructed wetlands.Rhizofiltration is the process of absorption of contaminants present in the rhizosphere into the root system of plants. This remediation process is used to decontaminate aquatic ecosystems using aquatic or land plants. During the utilization of this process, plants are grown on the contaminated site (in situ) or in an ex situ environment. Contaminants are absorbed through plant roots until saturation is reached, and finally, the plants are harvested with their roots. As the accumulation of contaminants occurs in the roots without any translocation to the shoots, there is an extremely low chance of atmospheric contamination.

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VI. RESULTS & DISCUSSIONS

A. Physico-chemical examination of Futala Lake Water

Macrophytes / aquatic plants grow normally in water bodies polluted by nutrients of varied sources and utilized the nutrients to produce large amount of biomass. The results of physico-chemical analysis of lake water before & after the remediation by using a submerged aquatic plant Hydrilla verticillata Casp shown in (Table –5.1). Physical parameter Temperature plays an important role in change of various chemical parameters and physiological process of aquatic plant. pH Value was recorded around 7.0 before culture but after the culture (ending of the experiment) little increase was noticed due to reaction of aquatic plant in water.
Turbidity and Salinity values were decreased after the culture during the entire study period.

Table 5.1: Physico-chemical characteristics of Lake water before& after the culture of "Hydrilla verticillata"

1.	Temperature	Celcius	24.8	22.9
2.	pH	.	6.98	7.63
3.	Turbidity	NTU	18.1	10.1
4.	Salinity	‰ (permil).	0.553	0.469
5.	Electrical Conductivity	Mmhos	835.10	720.30
6.	Total Oxygen Demand	Ppm	538.10	468.90
7.	Total Alkalinity	mgCaCo/L	260	155
8.	Chloride	mg/L	108.45	103.10
9.	Dissolved Oxygen	mg/L	2.6	7.5
10.	Oxygen Saturation	%	33.3	82
11.	Chemical Oxygen Demand	mg/L	144	100.8
12.	Total Hardness	mg/L	335.62	256.08
13.	Calcium Hardness	mg/L	184.14	140.58
14.	Calcium	mg/L	73.80	56.34
15.	Magnesium	mg/L	36.46	27.68
16.	Ammonical–N	mg/L	12.89	6.74
17.	Nitirite-N	mg/L	0.362	0.242
18.	Nitrate-N	mg/L	57.04	29.11
19.	Total Phosphate	mg/L	1.657	1.154
20.	Organic Phosphate	Mg/L	0.795	0.593

A minor variation was observed in chloride contents due to its non-utilization by the aquatic plant. In domestic wastewater Dissolved oxygen and Percentage oxygen saturation values were increased significantly, after the experiment, as Hydrilla verticillata Casp played a vital role in oxygen transfer in to water system. Nitrogen contents were examined as Ammonical, Nitrite and Nitrate form. As Nitrate nitrogen is the stable product of oxidation.

B. Percentage changes in physico-chemical parameters

1) Physical changes:

Temperature minimized 9.89 percentage and pH shifted above of 6.58 %. Reduction in Turbidity, Salinity noticed 37.00 and 17.42 %. Due to ionic absorbing tendency of Hydrilla verticillata Casp in experiment, Electrical conductivity and Total dissolved solids were deducted in 15.66 and 15.80 % relatively.

2) Chemical changes:

34.50 % Reduction was found for Total alkalinity. Remarkable utility of Carbon dioxide in photosynthetic activity Total and Free carbon dioxide reduced in 51.56 and 36.91 %. Because of significant release of oxygen in water by Hydrilla verticillata Casp Dissolved oxygen values increased to 140.1 % and Oxygen saturation 113.0 %. Little change in Chloride (4.38%) was found. Chemical oxygen demand decline average of 36.14 %. Total hardness, Calcium hardness, Calcium, Magnesium values were reduced by percentage of 28.71, 24.96, 24.39 and 37.16 individually.

More than 39.00 % reduction rate was noticed for Nitrogenous and Phosphorous compounds like Ammonical – N (39.45 %), Nitrite – N (47.59 %), Nitrate – N (50.35 %) and Total ortho phosphate (52.58%), Acid hydrolysable phosphate (42.85 %) and 44.69 % for Total phosphate. Organic phosphate reduction value in percentage was 36.41 after the experimentation in lake water with Hydrilla verticillata Casp.

VII. CONCLUSION

It is noted that CWs are now being increasingly used for environmental pollution control. Constructed wetlands were implemented in a wide range of applications, such as water quality improvement of polluted surface water bodies, wastewater on-site treatment and reuse in rural areas, campuses, recreational areas and green architectures, management of aquaculture water and wastewater, tertiary treatment, and miscellaneous applications. Water monitoring results obtained from several demonstrations show that CWs could achieve acceptable wastewater treatment performances in removing major pollutants, including suspended solids, organic matters, nutrients, and indicating microorganisms, from wastewater influent. The results indicate that if constructed wetlands are appropriately designed and operated, they could be used for secondary and tertiary wastewater treatment under local conditions, successfully. Hence constructed wetlands can be used in the treatment train to upgrade the existing malfunctioning wastewater treatment plants, especially in developing countries. During hydraulic retention study, it was found that the BOD, COD was best removed in planted wetland than unplanted wetland. It is because of the oxygen diffusion from roots of the plants and the nutrient uptake and insulation of the bed surface. It is also found that the increases in the detention period of the wastewater the removal rate also increases.

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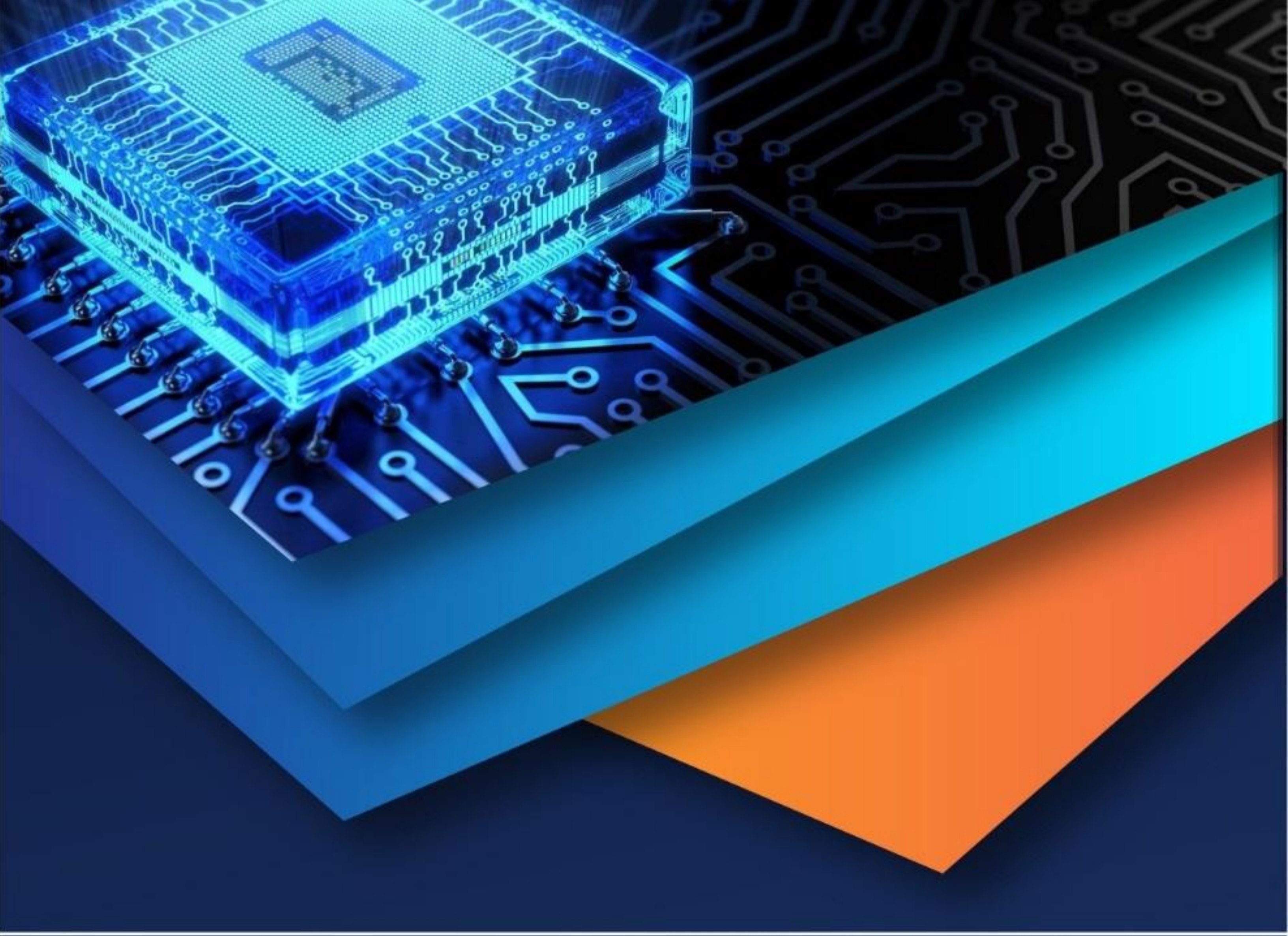

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