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Lab Scale Study of Water Hyacinth for Bioremediation of Waste Water

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Abstract-In the developing countries like India waste water treatment is being serious techno-economic problem in big cities, particularly in mega and metro cities. There are lots of parameters for the measurement of pollution level in the polluted waste water like pH, TDS, Acidity, alkalinity, chlorides, phosphates, COD, BOD, TOC and many more. Among all these parameters COD (*Chemical Oxygen Demand*) is a prominent factor which is hazardous for human health. In this time of industrialization and urbanization decreasing of COD is main concern for most of environmental scientists. In this present study we have carried out a laboratory scale experiment for reduction of COD level by bioremediation technique. In this research work we used Water Hyacinth (*Eichhornia Crassipes*), *Ceratophyllum* and *Azolla Pinnata* aqua plants for sewage water COD level reduction. For the experiment we prepared three combinations of phytoremediation system: WC (Water hyacinth and *Ceratophyllum*), WA (Water hyacinth and *Azolla Pinnata*) and W (Only Water Hyacinth). After three weeks bioremediation of sewage water treatment we got significant results showing 65 to 85 % reduction of COD level in all three systems.

Index Terms- Sewage Treatment, Eichhornia Crassipes, *Ceratophyllum*, *Azolla Pinnata*, COD

1. INTRODUCTION

Clean water is the basic need of all types of living on the earth. And there for it is widely recognized that sustainable, effective and better management of our natural water resources demands a sustainable approach which can link our socio-economic development with protection of the environment of our globe. Due to urbanization a number of environmental problems accurse such as water supply, wastewater generation and its collection, treatment and disposal of waste water in urban areas. Most of the municipal corporations are facing sewage treatment problems which are more complex due to the volume of the wastewater is large and it requires huge area for reducing COD level.

Bioremediation is a low cost and environmentally safe instead of conventional methods of wastewater treatment. One of the large problems occurring in the sewage waste water is the high amount of nutrients resulting from daily human activities, industrial discharge, runoff from agricultural and land drainage. Present study highlight treatment of sewage waste water by the combination of *Ceratophyllum*, water hyacinth and *Azolla*. Combinations of this we have been analyzed and controlled on the bases of Chemical Oxygen Demand (COD) which is a better representative of pollution parameter for sewage waste water. Conventional effluent treatment plant involves use of addition chemicals uses of chemical for neutralization, coagulation, chemical precipitation, deodorization, filtration like NaOH, H_2SO_4, polyelectrolyte, charcoal, chlorine which reduces COD and BOD, but at expenses of chemicals. Generally in ETP(effluent treatment plant) plant ,finally effluent passes through membrane in which metal , bacteria and other pollutant, which have size less than membrane pore are passes and difficult to control them.

In this present study during literature survey we found that there are some non-conventional biological water treatment methods can be useful for reducing the COD level from sewage waste water. Recently B. Ravi Kumar (Nov.-2013) and co-researchers have found some possibility of bioremediation of sewage using specific microbial consortium and biogenic filter materials [1]. M. Jaikumar (2012) suggested the usefulness of Water Hyacinth to treat the water pollution of Velachery Lake, Chennai [2].

Uhram Song et. al. (2012) proved the ability of water fern *Azolla* to treat the polluted water [3]. Dai Yanran et. al. (2012) studied about the Effects of the submerged macrophyte *Ceratophyllum* for the treatment of waste water [4]. M. Foroughi et. al. (2010) analyzed the pollution removal capacity of *Ceratophyllum*. and found significant results from their experiments [5].

Bioremediation involves reduction in COD by absorbing chemical compounds to grow itself not by adding other chemicals, but also effluent treatment uses oxygen for reducing COD(aeration) while water hyacinth uses carbon dioxide to grow(by photosynthesis fixation). By bioremediation techniques actually plants absorb small molecules and bacteria readily than larger one as this process involves absorption by its root, so it must depends on root pore size. Here larger molecules decompose by bacteria and converted to smaller one which are feasible for absorption by roots [6]. So, phytoremediation is a better technology that has an ability to treat wide range of waste water.

Bioremediation has been used extensively for treating sewage waste water, dyeing industry, metal removal, pesticide effluent, petroleum hydrocarbon
Compounds etc. In this present work an attempt is been made to assess efficiency, suitability of aquatic plants like water hyacinth, *Ceratophyllum* and *Azolla* to treat sewage wastewater.
These aquatic plants have drawn more attention because of its rapid growth and capability to remove varieties of pollutants from domestic and industrial effluents. They are also having capability to remove even nutrients and other organic chemicals and inorganic elements from domestic sewage and industrial effluents [7].

2. MATERIALS AND METHODS

2.1. *Aqua fern and plants*

From the literature survey we found water hyacinth as an aqua plant(weed), *Azolla* as an aqua fern and *Ceratophyllum* as an important aqua submerged plant which are more used for water treatment.

2.1.1. Water Hyacinth:

Water hyacinth (*Eichhoria crassipes*) is a free-floating perennial plant that can grow to a height of 3 feet. The dark green leave blades are circular to elliptical in shape attached to a spongy, inflated petiole. Underneath the water is a thick, heavily branched, dark fibrous root system. The water hyacinth has striking light blue to violet flowers located on a terminal spike. This plant is found in huge quantity near the study area.

Fig.1: Water Hyacinth

2.1.2. Ceratophyllum:

Coontail, or sometimes called hornwort, is a dark olive-green, rootless submerged perennial plant that often forms dense colonies. Leaves are relatively stiff, whorled with many forks and small teeth along one edge. The tips of branches are crowded with leaves giving it a "coontail" resemblance. Coontail reproduces by seeds and fragmentation.

Fig.2: Ceratophyllum

2.1.3. Azolla:

Mosquito Fern or *Azolla* is a small free-floating fern approximately 1 to 3/8 inches wide. Leaves of the mosquito fern overlap giving a quilted look to the surface and hide the stem. A single root protrudes from each stem. Mosquito ferns can vary in color from green to red and are generally found in quiet ponds protected from wind action. Mosquito ferns can be aggressive invaders in quiet ponds and are often found mixed in with duckweeds. If these fern colonies cover the surface of the water, then oxygen depletions and fish kills can occur. These plants should be controlled before they cover the entire surface of the pond.

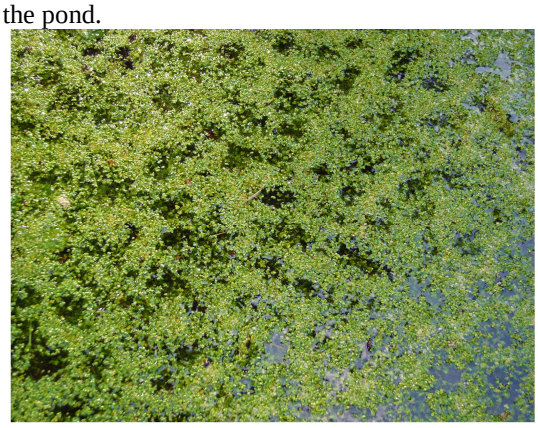

Fig.3: Azolla

2.2. *Sampling*

Total five samples of sewage waste water were collected from water pump (pump draught water from khadi to effluent treatment plant for treatment) with two hours' intervals because contamination at different time may also differ. The five samples were mixed to make one better representative sample of sewage waste water. Then this sample was divided into three equal parts. The samples were collected in the month of January, 2014. All samples were collected in high density plastic black colored containers of 35 liter capacity of each and brought to Chemistry Laboratory at Government Engineering College, Valsad where we had done experiment. All containers before experiment (which were used for taking samples) were dried properly in sunlight for 3 hours and plastic tubs (which were used for lab scale study) were cleaned properly, first with dilute nitric acid than with distilled water two time. At the time of starting study tubs are cleaned with ambient water. During whole study proper grade chemicals were used. The analysis is based on APHA for examination of water and wastewater [9].

2.3. *Collection of Plants and Ferns*

The plants of Water Hyacinth, *Ceratophyllum* and *Azolla* were collected and identified from Segvi Lake located near Tithal beach in Valsad city in January, 2014. We had collected fresh water hyacinth plants with lavender color flowers, light green fresh *Ceratophyllum* submerged plants from pond were collected and free floating *Azolla* fern were collected from the surface of the lake.

2.4. *Experimental Setup*

For the experimental work we prepared three combinations of these aqua plants and fern as follows:

I) Water Hyacinth + *Ceratophyllum* (WC)
II) Water Hyacinth + *Azolla* (WA)
III) Water Hyacinth alone (W)

Total 2.5 kg of biomass of above combination was put in black colored tub which was previously filled with 30 liters of sample in each. Than these set up was placed in sun light. Initial COD level was measured each combination immediate after putting the plants and fern.

After every 24 hours COD level was measured for each of the combination. The results are shown in the Table-1. These continuous readings were taken for 25 days.

3. Results and Discussions:

From the results it was shown that day by day the COD level of all three combinations were found decreased. But the physical observation of the plants indicated that in combination II (WA) the *Azolla* ferns were initially active but after one week of time its color became brown and the reduction rate of COD level which was higher in beginning, found lower. While in combination I (WC) the rate of COD level reduction was found quite well.

Table-1. Measurements of COD

Initial COD in all three combination was 2580 ppm			
Day	COD in ppm		
	Comb. WC	Comb. WA	Comb. W
0	2580	2580	2580
1	2340	2335	2377
2	2118	2101	2182
3	1923	1938	1996
4	1738	1767	1819
5	1571	1603	1664
6	1420	1454	1524
7	1274	1324	1404
8	1141	1213	1309
9	1017	1118	1228
10	901	1032	1159
11	796	952	1100
12	704	895	1053
13	629	850	1020
14	570	820	991
15	523	786	971
16	484	761	953
17	454	741	938
18	432	726	925
19	417	715	912
20	407	702	902
21	397	693	896
22	388	688	890
23	380	685	890
24	370	685	-
25	365	-	-

And in the Combination III (W) the plants of water hyacinth were became yellow after 15 days and were became complete yellow after 22-23 days. Hence the reduction of COD level was also not found near to nil at the ending of plant life.

The final results are given in the Table-2 this shows the percentage amount of COD level reduced by the particular plants combination within the time period of 22 days.

Table-2. Percentage reduction of COD level.

Combination	Initial COD	COD Remained after 22 days	Net Reduction in COD	After 22 days % of COD reduced
WC	2580	388	2192	84.96 %
WA	2580	688	1892	73.33 %
W	2580	890	1690	65.5 %

Analysis of results can be done from the Figure-4 to Figure-7. This graphical representation (Figure-8)

indicates the comparison of per day (Day to Day) reduction of COD level in all three combinations. The Figure-9 shows the percentage of COD reduction done by the particular plant combination.

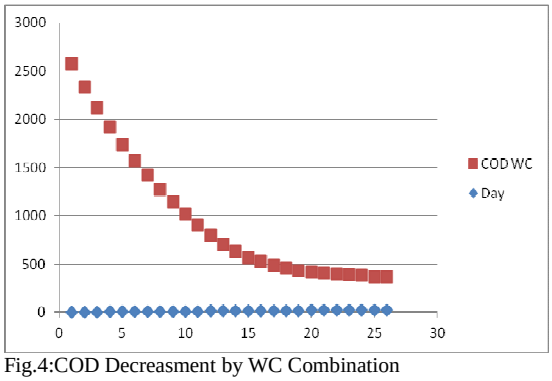

Fig.4:COD Decreasment by WC Combination

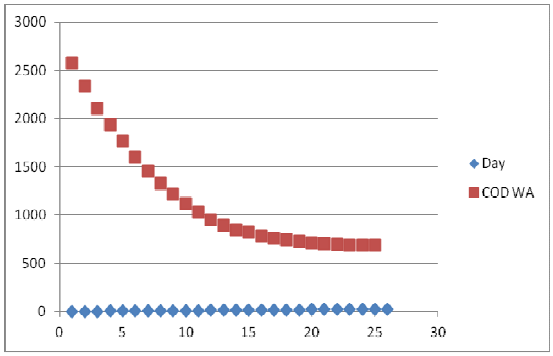

Fig.5:COD Decreasment by WA Combination

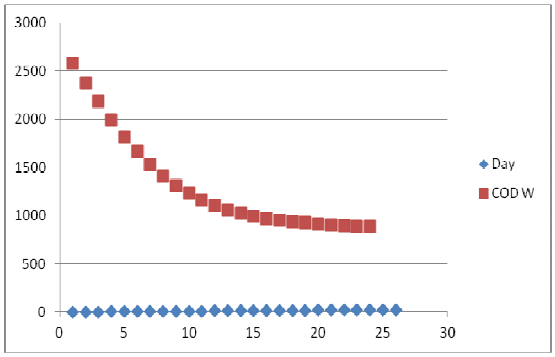

Fig.6:COD Decreasment by Water Hyacinth

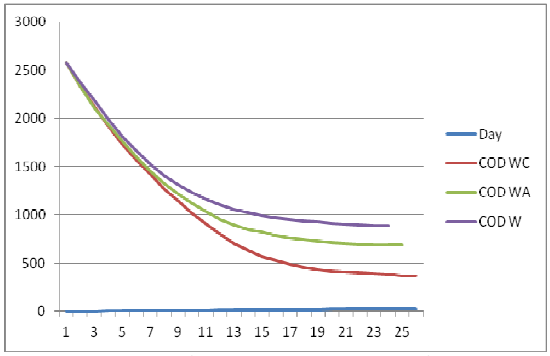

Fig.7: Comparision of COD removing capacity of WC, WA and W.

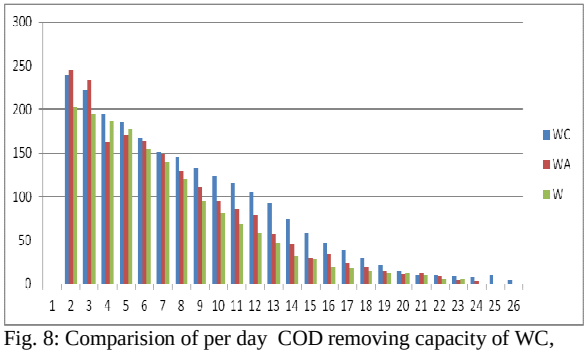

Fig. 8: Comparision of per day COD removing capacity of WC, WA and W.

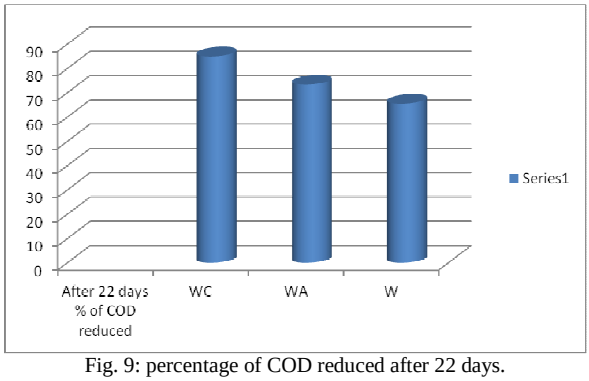

Fig. 9: percentage of COD reduced after 22 days.

4. Conclusion:

From the results obtained during the phytoremediation process in all three combinations it is well proved that all the three combinations are having significant power to remove COD increasing contaminants from polluted water. In addition to this it is also been proved that water hyacinth and *Ceratophyllum* combinative treatment is more convenient and useful to reduce COD level. The results show that if more time would be given than this combination can remove almost of the COD increasing contaminants

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