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An Experimental Study Of Contaminant Removal Capacity Of Water Hyacinth From Waste Water

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Abstract— Water hyacinth (Eichhornia Crassipes) is fast growing perennial aquatic macrophyte and prolific free floating aquatic weed. It has ornamental as well as many economic and environmental uses. But due to their rapid and uncontrollable growth, they may cause harm to the water ecosystem, by clogging it in the form of impermeable mat. Removing of the formed mat is difficult task which requires a huge quantity of men, machine and money. This Research paper shows positive use of water hyacinth for removal of contaminants from waste water.

Keywords— Water Hyacinth, Phytatoremediation, Waste water, Contaminants.

I. Introduction

Land and water are precious natural resources on which rely the sustainability of agriculture and the civilization of mankind. Unfortunately, they have been subjected to maximum exploitation and severely degraded or polluted due to anthropogenic activities. In order to maintain good quality of soils and waters and keep them free from contamination, continuous efforts have been made to develop technologies that are easy to use, sustainable and economically feasible. The use of plant species for cleaning polluted soils and waters named as Phytoremediation has gained increasing attention since last decade, as an emerging cheaper technology. This mechanism of removal of contaminants from waste water with the help of Water Hyacinth has explained in this paper.

II. Literature Review

- **K.R. Aneja and Kulvinder Singh**, Department of Botany, Kurukshetra University made a comparative experimental analysis of physic- chemical factors between water hyacinth infested and uninfested water area. Authors found in this one year study calcium hardness free carbon dioxide, phosphate and sulphate content, Biochemical Oxygen Demand(BOD), Chemical Oxygen Demand(COD) were higher where as temperature, pH, Dissolved Oxygen, Nitrate were lower under water hyacinth cover.
- **Archana Dixit,** Maulana Azad National Institute of Technology, Bhopal illustrates the role of plants to assist the treatment of industrial and residential waste water in this review paper. They found remarkable ability of aquatic plants, particularly the water hyacinth to extract compounds and elements from contaminated water.
- **Phanankosi Moyo, Great Zembabwe University** studied the effectiveness of water hyacinth (Eichhornia crassipes) in remediating polluted water of Shagashe River in Masvingo, Zimbabwe. Analysis for electrical conductivity, total dissolved solids (TDS), sulphates, phosphates, total hardness, pH, nitrates, nitrites and total nitrogen on all samples was done. Statistical analysis was done to check if there was a significant reduction of the parameters moving downstream. The results indicate that water hyacinth can remediate the river as noted by the significant reduction in all these parameters.
- **Piyush Gupta** National Institute of Rock Mechanics, Kolar Gold Fields, India have explained the roll of Water Hyacinth, Water Lettuce and Vetiver Grass, origin and occurrence, ecological factors contributing there growth, and there efficiency in reduction of different water contaminants like TSS, TDS, electrical conductivity, hardness, biochemical oxygen demand, chemical oxygen demand, dissolved oxygen, nitrogen, phosphorous and heavy metals.
- **Alireza Valipour** has done a study to improve a shallow pond water hyacinth system by incorporating the advantages of engineered attached microbial growth technique (termed Bio-hedge) for on-site domestic wastewater treatment. As per the study nutrient removal efficiency mostly depends on the retention time, flow velocity and nutrient level in wetland systems. Authors also observed that there is considerable change in morphological characteristics of water hyacinth after 10 days of waste water treatment.
- **John Momanyi Mironga, Egerton University, Kenya** has studied effect of Water Hyacinth Infestation on the Physicochemical Characteristics of Lake Naivasha. The study

hypothesized that water hyacinth had significantly affected water quality of Lake Naivasha. Field measurements were done to determine the impact of water hyacinth on water quality. Two sampling sites were selected one under water hyacinth and another at shore line without water hyacinth to compare the results of the measurements. Water quality variables from the two habitats were compared by means of one-way analysis of variance. The sample analysis showed that free carbon dioxide was significantly higher in water hyacinth infested areas than in open water. Dissolved oxygen was significantly lower in the infested areas when compared with open water. Similarly pH was significantly lower in water hyacinth infested area than in open water.

III. Methodology

In order to decide the contaminant removal capacity of water hyacinth from waste water experimental set up was prepared. This set consists of enclosed tank with definite dimensions for growing water hyacinth and had a provision for inlet and outlet. Testing Physico-Chemical characteristics of waste water sample at inlet before pouring it in to tank was done. Physico-Chemical analysis of waste water at outlet was done by providing suitable hydraulic retention time like 48Hrs, 72Hrs, 144Hrs, 216Hrs etc. At each interval of HRT biomass of water hyacinth was also measured. Thus observation is change in Physico-Chemical characteristics of water with respect to two variables, 1) Detention Time, 2) Biomass of Water Hyacinth.

A. *Parameters assessed*

- pH
- Dissolved oxygen (DO)
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Nitrates
- Sulphates
- Phosphates

TABLE I. PARAMETERS TESTED AND METHOD USED FOR IT

Sr. No.	Test	Method of Determination
1	pH	pH Meter
2	DO	IS: 3025 (Part 38)
3	BOD	IS: 3025 (Part 44)
4	COD	IS: 3025 (Part 58)
5	Ntrates	Cadmium Reduction Method (Method 8039) by Spectrophotometer
6	Sulphate	USEPA SulfaVer 4 Method (Method 8051) by Spectrophotometer.
7	Phosphates	PhosVer Method (Method 8048) by Spectrophotometer.

B. *Experimental Model Setup*

Model is made from plastic water tank rectangular in shape and having total capacity of about 825lit. The tank has length of 1.4 meter, width 0.45meter and depth 0.6meter. The top surface area is 1.38 meter^2, which is sufficient space for growth of water hyacinth during a experimental period. The total depth of tank is 0.6 meter which fixed by considering freeboard of 10cm and depth of water hyacinth roots 20cm to 25cm. Outlet is provided for collection of water for physico chemical analysis at a depth of 0.35meter from water surface.

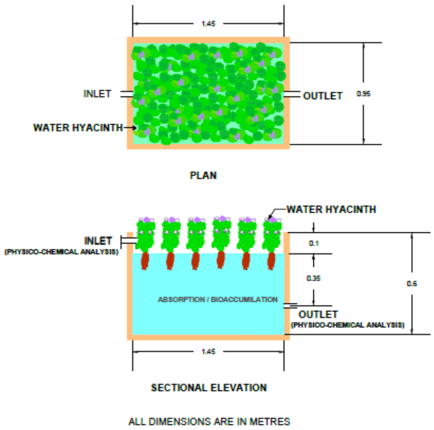

Fig. 1. Experimental Model Setup

C. *Collection of Samples*

A model was set up at Kasarwadi Sewage Treatment Plant, which receive domestic waste water from Pimpari Chinchwad area. The plant treats total 120 MLD waste water in 3 phases. Each phase having capacity of 40MLD. After treatment water is discharged in to The Pawana River by maintaining its discharge standards. For the decided experimental set up, water was collected from PST of sewage treatment plant. About 700 lit. Of waste water poured in to model. Physico chemical analysis of sample, i.e. testing of pH, DO, BOD, COD, Nitrates, Sulphates and Phosphates was done before pouring in to model**.**

D. *Collection of Water Hyacinth*

Basic aim of research is to assess a contaminant removal capacity of water hyacinth from waste water. The plants required for this was obtained from Punavale Bandhara on The Pawana River, located at Ravet. Plants simply picked up from river and removed its dry leaves and cleaned roots to remove dirt attached to it. Cleaning of roots increases rate of contaminant removal. These plants were acclimatized to laboratory conditions for two days before starting research. Plants were weighted by attaching to wire mesh before setting in to model.

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IV. RESULTS

TABLE II. RESULTS SHOWING PRESENCE OF CONTAMINANTS IN WATER AT RESPECTIVE DATE.

Sr. No.	Test \ Date	01-Jan 17	03-Jan 17	06-Jan 17	09-Jan 17	12-Jan 17	18-Jan 17	24-Jan 17	30-Jan 17	07-Feb 17	14-Feb 17
1	Biomass(Kg)	4.5	4.52	5.57	6.89	8.59	10.15	11.98	12.53	13.01	13.29
2	pH	6.75	6.83	6.9	7.1	7.42	7.4	7.43	7.6	7.86	7.76
3	DO(mg/lit)	0	0.9	2	2.4	2.9	3.9	4	4.1	4.1	3.8
4	BOD(mg/lit)	180	161	100	38	28	26	25	10	6	10
5	COD(mg/lit)	528	465	250	198	126	80	76	60	40	44
6	Nitrates(mg/lit)	22.6	19.9	15	4.1	2.1	1.5	1.2	1	1.3	1.48
7	Sulphates(mg/lit)	10.96	10.32	9.45	8.19	7.1	5.52	4.12	3.3	2.1	1.1
8	Phosphates(mg/lit)	9.89	9.3	8.01	6.72	5	2.47	0.15	0.11	0.14	0.19

TABLE III. % REMOVAL OF CONTAMINANTS W.R.T. HRT AND BIOMASS

Sr. No.	Test \ HRT	3D	6D	9D	12D	18D	24D	30D	38D	45D
1	Biomass(Kg)	0.44	23.78	53.11	90.89	125.56	166.22	178.44	189.11	195.33
2	pH	1.19	2.22	5.19	9.93	9.63	10.07	12.59	16.44	14.96
3	DO(mg/lit)	……	122.22	166.67	222.22	333.33	344.44	355.56	355.56	322.22
4	BOD(mg/lit)	-10.56	-44.44	-78.89	-84.44	-85.56	-86.11	-94.44	-96.67	-94.44
5	COD(mg/lit)	-11.93	-52.65	-62.50	-76.14	-84.85	-85.61	-88.64	-92.42	-91.67
6	Nitrates(mg/lit)	-11.95	-33.63	-81.86	-90.71	-93.36	-94.69	-95.58	-94.25	-93.45
7	Sulphates(mg/lit)	-5.84	-13.78	-25.27	-35.22	-49.64	-62.41	-69.89	-80.84	-89.96
8	Phosphates(mg/lit)	-5.97	-19.01	-32.05	-49.44	-75.03	-98.48	-98.89	-98.58	-98.08

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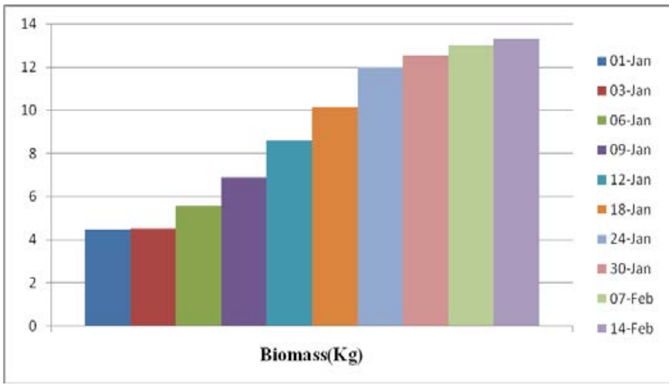

Fig. 1 Increase in Biomass of water hyacinth w.r.t. HRT

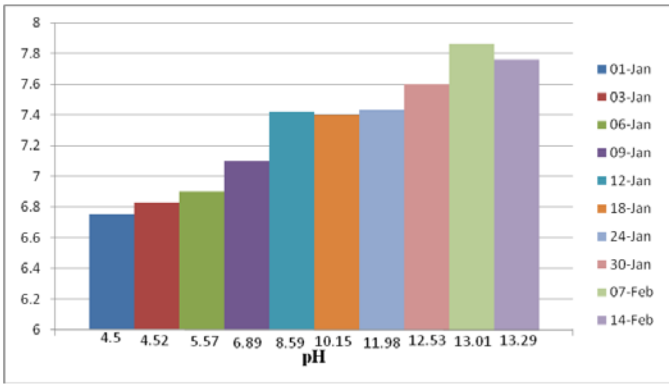

Fig. 2. Change in pH value w.r.t. HRT and Biomass

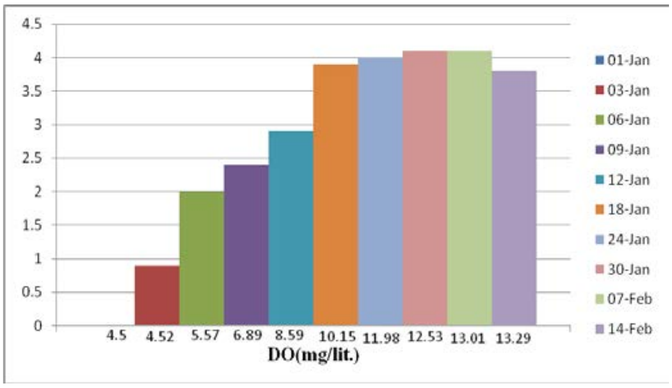

Fig. 3. Change in Dissolved Oxygen w.r.t. HRT and Biomass

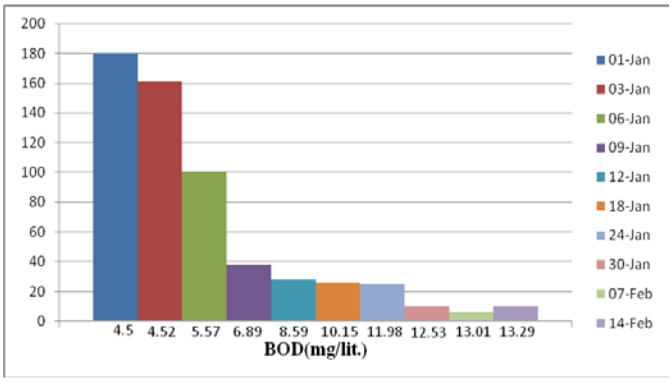

Fig. 4. Change in Biochemical Oxygen Demand w.r.t. HRT and Biomass

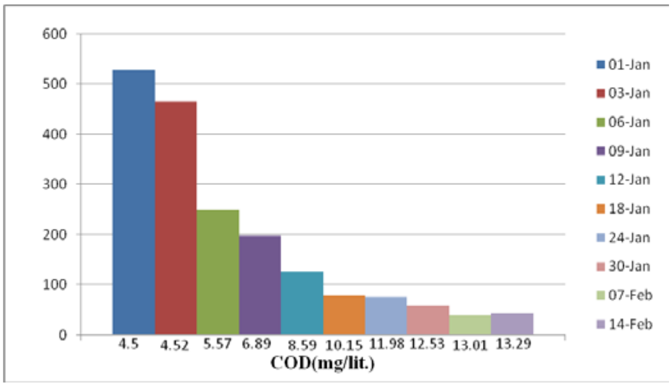

Fig. 5. Change in Chemical Oxygen Demand w.r.t. HRT and Biomass

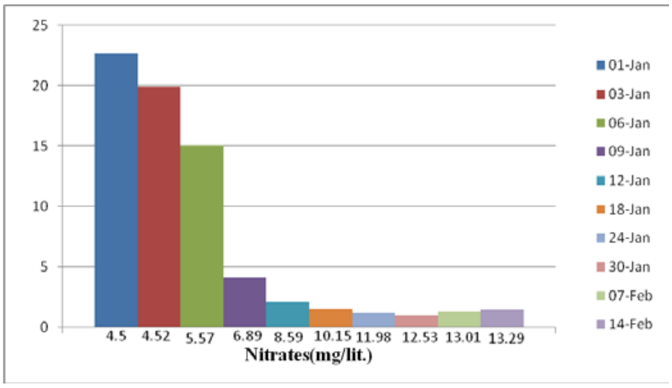

Fig. 6. Change in Nitrogen content ($NO3^{-}$) w.r.t. HRT and Biomass

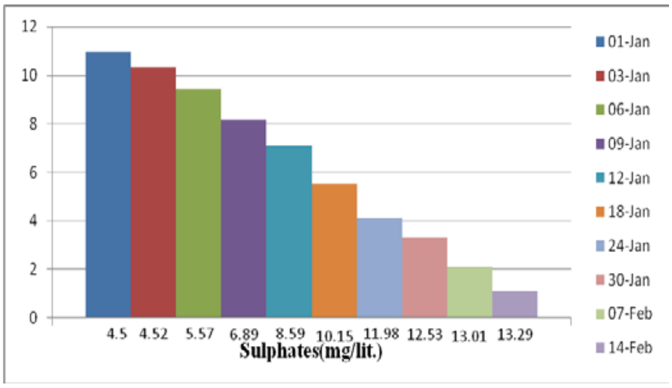

Fig. 7. Change in Sulphate content ($SO4^{--}$) w.r.t. HRT and Biomass

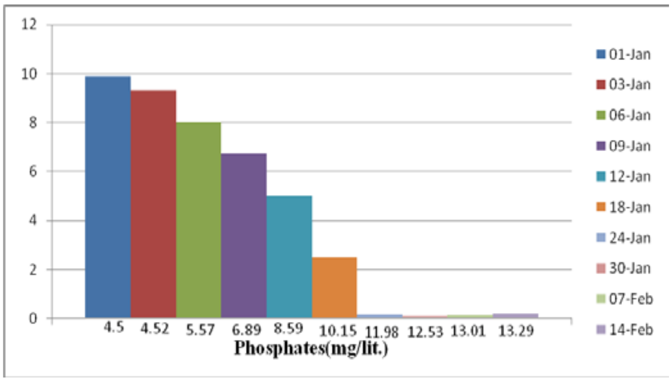

Fig. 8. Change in Phosphate content ($PO4^{---}$) w.r.t. HRT and Biomass

V. DISCUSSION

The experimental work was done from date 01/01/2017 to 14/02/2017 for total 45 days. Up to date 12/01/2017 testing of physico chemical characteristics was done at an interval of 3 days where rate of contaminant removal was higher. From 18th day of experimentation there was decrease in rate of reduction of contaminant, thus testing was done at an interval of 6 days.

- *Biomass*: Initial biomass of Water Hyacinth was 4.5 kg, which has shown very less rate of growth i.e. 0.44% for first 3 days. As it start getting nutrient supply, plants shows exponential rate of increase in biomass, i.e. by 166.22% till 24 days. Again it shows reduction in growth of biomass as there is less availability of nutrient in waste water. During total period of experimentation water hyacinth shows growth by 195.33%.

- *pH*: The pH value of waste water indicates the negative log of hydrogen ion concentration present in waste water. It is thus an indicator of the alkalinity of waste water. At an inlet of model pH of waste water was 6.75 which has been changed to 7.76 in 45 days of experimentation.

- *Dissolved Oxygen (DO):* DO is a major factor which affects almost all living organisms in water. At inlet DO present was nil, but it shows conspicuous growth i.e. 4.1 mg/lit till 30/01/2017. This is in accordance with Hussainy(1967), Yentch & Ryther (1957) who regarded as a effect of photo-oxidation by pigments. After 30 days of experimentation, there is decrease in DO till 14 Feb. because of degradation of shaded leaves of Water Hyacinth and formation of mat on the water surface in model.

- *BOD:* Biochemical Oxygen Demand. It is a demand of oxygen by bacteria to decompose the biodegradable organic matter. Results show about 95% reduction in BOD from tested water in whole experimental period, which indicates Water Hyacinth, is very much effective in reduction of biodegradable organic matter. The results also show about 86% reduction of organic matter in 24 days, after which there is decrease in the rate of reduction of BOD. In a last week BOD increased by 4mg/lit. , it is an effect of shading of leaves of plants.

- *COD:* Chemical Oxygen Demand. From results obtained it can be concluded that Water Hyacinth is also effectively remove a non biodegradable organic compounds. Plants have removed COD by 92% in 45 days of experimentation. There is increase of COD by 4mg/lit. in a last week which also indicates shading of leaves of plants.

  According to review paper by Piyush Gupta, presence of Water Hyacinth in water depletes CO_2 during a period of photosynthesis activity and an increase in dissolved oxygen which creates aerobic conditions favorable for aerobic bacterial activity to reduce a BOD and COD.

- *Nitrates, Sulphates and Phosphates*: Like most plants, nitrates, sulphates and phosphates are nutrients which plays vital role in a growth of Water Hyacinth. These nutrients are absorbed by plants via fibrous root system, which ultimately reduces its concentration from waste water.

Results indicate that there in about 93% reduction of nitrates from waste water within 18 days. After it shows decrease in rate of removal of nitrates. Results also shows increase of nitrates by 0.48mg/lit. in a last two weeks of experimentation.

Water Hyacinth also acts effectively for removal of sulphates from waste water. There is constant progressive reduction of sulphates for complete experimental period. Plants have shown capacity to remove sulphates by 90% in a period of 45 days.

Water Hyacinth has shown greatest efficiency for reduction of phosphates, i.e. 98.08% in 45 days. It takes 24 days for removal of 98.48% of phosphates, but after 24 days it has shown a little increase by 0.04mg/lit.

VI. Conclusion:

Water Hyacinth considered as a nuisance because of its tendency of uncontrolled growth and troubles caused by it. But plants have shown great ability to remove contaminants from waste water and other natural water bodies. We can use this plant in a positive way for removal of contaminates in a Phytoremediation treatment of waste water.

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