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Application of Hydrophytes in Phytoremediation Technology for the Treatment of Wastewater

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ABSTRACT: A constructed wetlands (CW) are an artificial wetland to treat municipal or industrial wastewater. They are engineered systems to utilize the natural functions of wetland vegetation, soils and their microbial populations to treat wastewater. The objective was to treat wastewater by constructing low cost, low energy process wetlands with minimal operative attention. In present paper, water hyacinth plant was tried to reduce the pollutant load of agrochemical wastewater in a constructed wetland. It was found that the system was capable of removing pollutants and the hydrophytes. Ability to survive in high concentration of nutrients with significant nutrient removal was also studied. Primary Treated wastewater sample from agrochemical industry were tested on weekly basis to calculate 'C.O.D., B.O.D., total suspended solid, total dissolve solid, , Ammonical Nitrogen'.

KEYWORDS: Constructed wetlands, Subsurface –flow, Typha angustata, Treatment

I. INTRODUCTION

In the present century supply of adequate water resources as well as effect on environmental due to contaminated water are major challenges. The problem of polluted water is expected to increase due to rapid urbanization. Hence, it is necessary to take required measures to control and treat effluents. It is often argued that the traditional disposal base system have to be transformed into conservation based waste water management system, which should be able to contribute in solving waste water related problems. Wastewater is defined as a combination of the liquid or water carried wastes removed from residence, institution, industrial and commercial establishments [1].

Constructed wetlands has received significant attention throughout the world (CWs) as natural, low cost, eco-technological biological waste water treatment technology. They are designed to mimic processes found in natural wetland ecosystems, which is now standing as the potential alternative or supplementary systems for the treatment of waste water[2]. One of the most common applications of constructed wetlands has been the treatment of primary or secondary domestic sewage effluent. Constructed wetland systems modeled after those for domestic wastewater are being used to treat the high organic loads associated with agriculture [3],[4].

II. MATERIAL AND METHODS

The Vertical flow constructed wetland was constructed at the A-5, Jivandeep society, Bholav, Bharuch (Latitude 21.70510N, Longitude 72.99590E) Gujarat , India. The constructed wetland systems, had Typha angustata with vegetation which are located from lake in bholav village of district Bharuch. The Constructed Wetland lab model was made of plastic container of capacity 0.65cu.m. as shown in figure 2.

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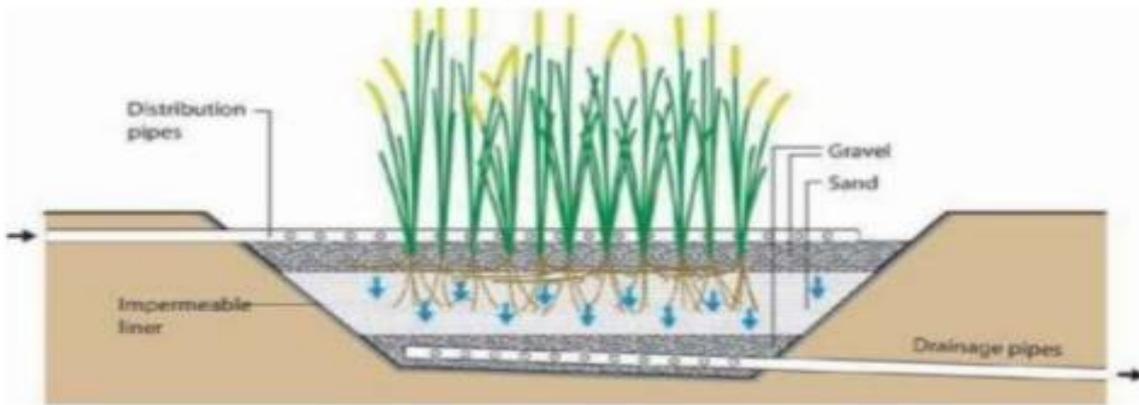


Figure -1 Schematic cross-section of vertical flow constructed wetland

- Preparation of Bed

The constructed wetland had a height of 0.63m in which 0.03m and was left open on top for loading the wastewater. Only 0.6m was used to make the wetland bed out of which 40% was used to make the wetland and the rest 60% was used for substrate. The soil media had a depth of 0.24m, below the soil layer very small pebbles (0.01-0.012m) were placed, the depth of pebbles layer was 0.12m. The Middle layer was made of small stones (0.02-0.03m) having a depth of 0.12m. The bottom of wetland unit was formed by big gravels (0.04-0.05m) having depth of 0.12m. 431 plants of *Typha angustatifolia* species were placed in the soil at a depth of 0.20m. The wastewater was retained for a maximum of 7 days HRT. The flow rate was 0.006m³/day. Samples were taken daily at an interval of 24 hr. The analysis was done as per APHA standard method for testing water and wastewater (21st edition) [5]. pH, TSS, TDS and Conductivity of samples were analysed at shri K.J.Polytechnic, Bharuch and C.O.D., B.O.D., Chloride, Sulphate and Ammoniacal Nitrogen Samples were analysed at Vairagya Consultant, Bharuch, Gujarat.

The Tank is open top plastic material with an outlet pipe fitted at the bottom most side for the collection of outlet water. The dimensions of the tank mentioned in the table 1 and practical setup of the tank and dimension of model shown in Figure 3 and Figure 4.



Figure 2 *Typha angustatifolia* setup

Total depth	0.63 m
Total length	1.14 cm
Total width	0.95 m
Total surface area	1.083 m ²

Table 1: Dimension of tank

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(a) GRAVEL (Size:50mm-80mm)



(b) COARSE AGGREGATE (Size:20mm-40mm)



(c) FINE AGGREGATES (Size: 5mm-20mm)



(d) WETSOIL WITH SPECIES

Figure 3: (a) First layer of model (Gravel Size:50mm-80mm) (b) Second layer of model (Coarse Aggregate Size:20mm-40mm) (c) Third layer of model (Fine Aggregate Size:05mm-20mm) (d) Top layer of Wetland soil with species

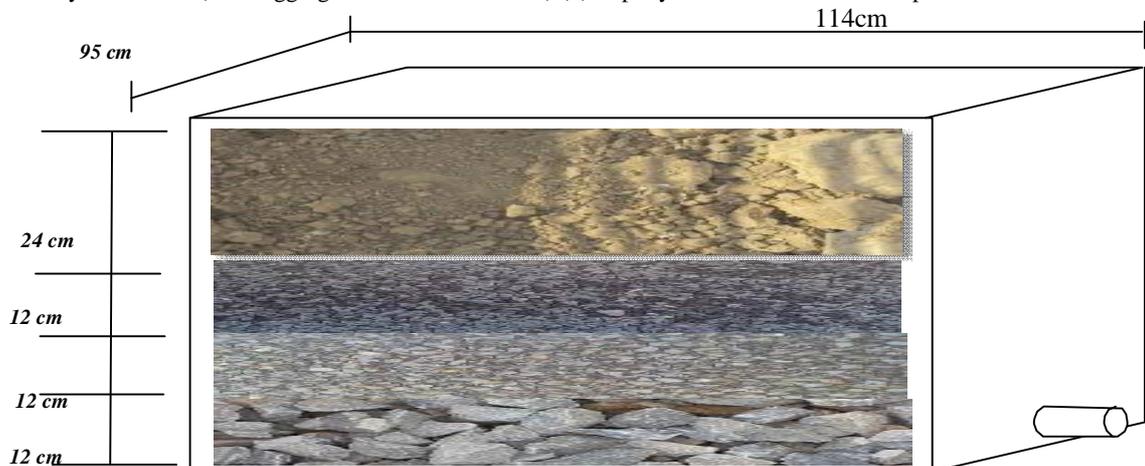


Figure 4: Dimension of the model

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III. EXPERIMENTAL RESULT

The wastewater Average evaporation rate is 3 to 5 liter per day. Data is collected and tabulated in table 2 and figure 3. Therefore evaporation will be the major factor affecting the parameter in the project. Also Table 3 shows the Climatological data of Bharuch IMD station. Table 4 shows Physico-chemical parameters of effluent at 7HRT after treatment of phytoremediation (*Typha angustifolia*).

Table 2: Daily Evaporation of Wastewater from practical setup of model

Sr. No.	Days	Control		Sample 1		Sample 2		Sample 3		Sample 4		Sample 5	
		Inlet (l)	Outlet(l)										
1	Day 1	60.00	57.00	60.00	56.25	60.00	56.00	60.00	56.25	60.00	54.75	60.00	55.25
2	Day 2	57.00	52.50	56.25	51.50	56.00	51.25	56.25	50.75	54.75	49.25	55.25	51.25
3	Day 3	52.50	47.25	51.50	47.75	51.25	47.50	50.75	44.25	49.25	44.00	51.25	46.75
4	Day 4	47.25	43.00	47.75	43.00	47.50	42.00	44.25	38.00	44.00	39.50	46.75	40.50
5	Day 5	43.00	38.25	43.00	37.50	42.00	37.75	38.00	33.00	39.50	32.25	40.50	34.00
6	Day 6	38.25	34.50	37.50	33.75	37.75	31.25	33.00	29.50	32.25	28.00	34.00	29.25
7	Day 7	34.50	29.75	33.75	28.50	31.25	26.75	29.50	26.50	28.00	25.75	29.25	25.50

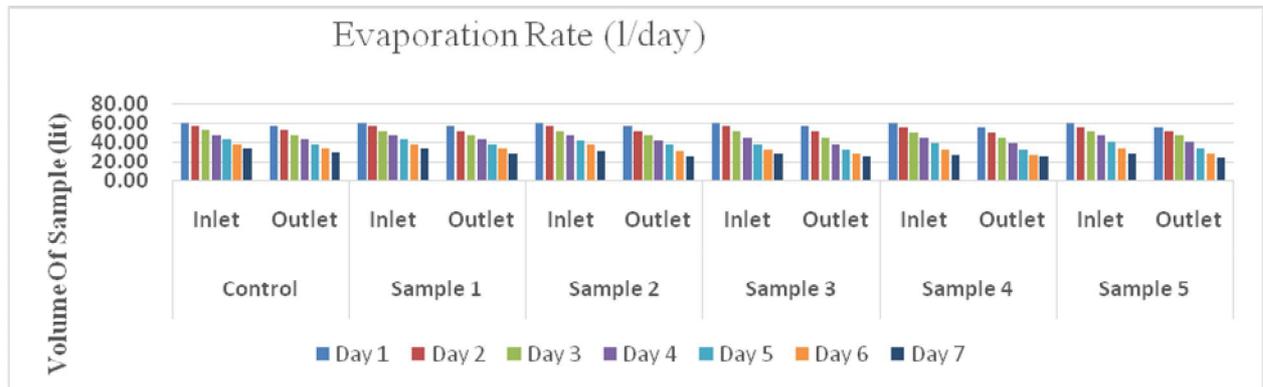


Figure 5: Graph of Daily Evaporation of Wastewater from practical setup of model

Table 3: Climatological data of Bharuch IMD station [6]

Month	Max Temp (Deg.C)	Mini Temp (Deg.C)	Humidity (%)	Wind Spd. Kmpd	Sunshine (Hours)	Solar Rad. (MJ/m2/d)	Eto (mm/d)	Rainfall (mm)	Wind Spd. Kmph
January	31.3	11.9	51.5	105.9	9.0	17.3	3.7	1.2	5.9
February	33.8	14.4	45.0	111.3	9.2	19.6	4.5	1.0	6.2
March	37.6	19.0	44.0	125.7	9.8	22.7	5.8	0.8	7
April	40.0	23.3	45.0	158.0	10.4	25.2	7.2	1.0	8.8
May	39.6	26.2	55.5	222.6	10.8	26.2	8.0	12.5	12.4
June	35.6	26.5	69.5	263.9	7.6	21.3	6.3	121.0	14.7

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Month	Max Temp (Deg.C)	Mini Temp (Deg.C)	Humidity (%)	Wind Spd. Kmpd	Sunshine (Hours)	Solar Rad. (MJ/m2/d)	Eto (mm/d)	Rainfall (mm)	Wind Spd. Kmph
July	32.0	25.5	81.0	237.0	4.4	16.5	4.3	307.6	13.2
August	31.2	25.0	83.5	206.4	4.2	15.9	3.9	243.1	11.5
September	32.6	24.4	76.0	154.4	6.3	18.1	4.4	197.6	8.6
October	35.9	22.0	59.5	102.3	7.9	18.5	4.5	35.2	5.7
November	34.8	16.9	52.5	84.4	8.0	16.5	3.7	3.7	4.7
December	32.2	13.2	53.5	93.3	8.9	16.5	3.4	0.1	5.2
Total	-	-	-	-	-	-	-	-	-
Average	34.7	20.7	59.7	155.4	8.0	19.5	5.0	924.8-	

Table 4 Physico –chemical parameters of effluent at 7HRT after treatment of phytoremediation

PARAMETER S	Initial	Control	Initial (1st)	Final (1st)	Initial (2nd)	Final (2nd)	Initial (3rd)	Final (3rd)	Initial (4th)	Final (4th)	Initial (5th)	Final (5th)
pH	7.23	6.95	7.34	7.01	7.25	7.02	7.5	7.17	7.72	7.32	7.38	7.29
TSS(mg/l)	922	300	662	180	984	244	656	500	2001	904	556	440
TDS(mg/l)	3215	6894	3432	8688	3132	8294	4514	9032	5964	9388	5296	10496
Conductivity (mS/cm)	6.428	13.78	6.86	17.37	6.26	16.58	9.03	18.06	11.93	18.77	10.59	20.99
Ammoniacal Nitrogen(mg/l)	60	52	66	8	60	7	93	9	149	14	115	21
BOD(mg/l)	500	309	541	108	500	89	523	94	590	118	389	100
COD(mg/l)	1789	963	1859	390	1789	363	1780	357	2143	439	1428	338
Chloride(mg/l)	1387	2017	1241	2699	1387	3017	1775	3333	2002	3003	1927	3353
Sulphate(mg/l)	499	784	494	1089	499	1101	359	2634	1810	2534	2427	3824

The graphical representation of Physico –chemical parameters of effluent chart (a,b,c,d,e,f) before and 7HRT after treatment of phytoremediation (Typha angustatifolia) are shown in figure 6 (a to e). The comparison of effluent of primary treated and treated effluent at 7HRT after treatment of phytoremediation is shown in Figure 7.

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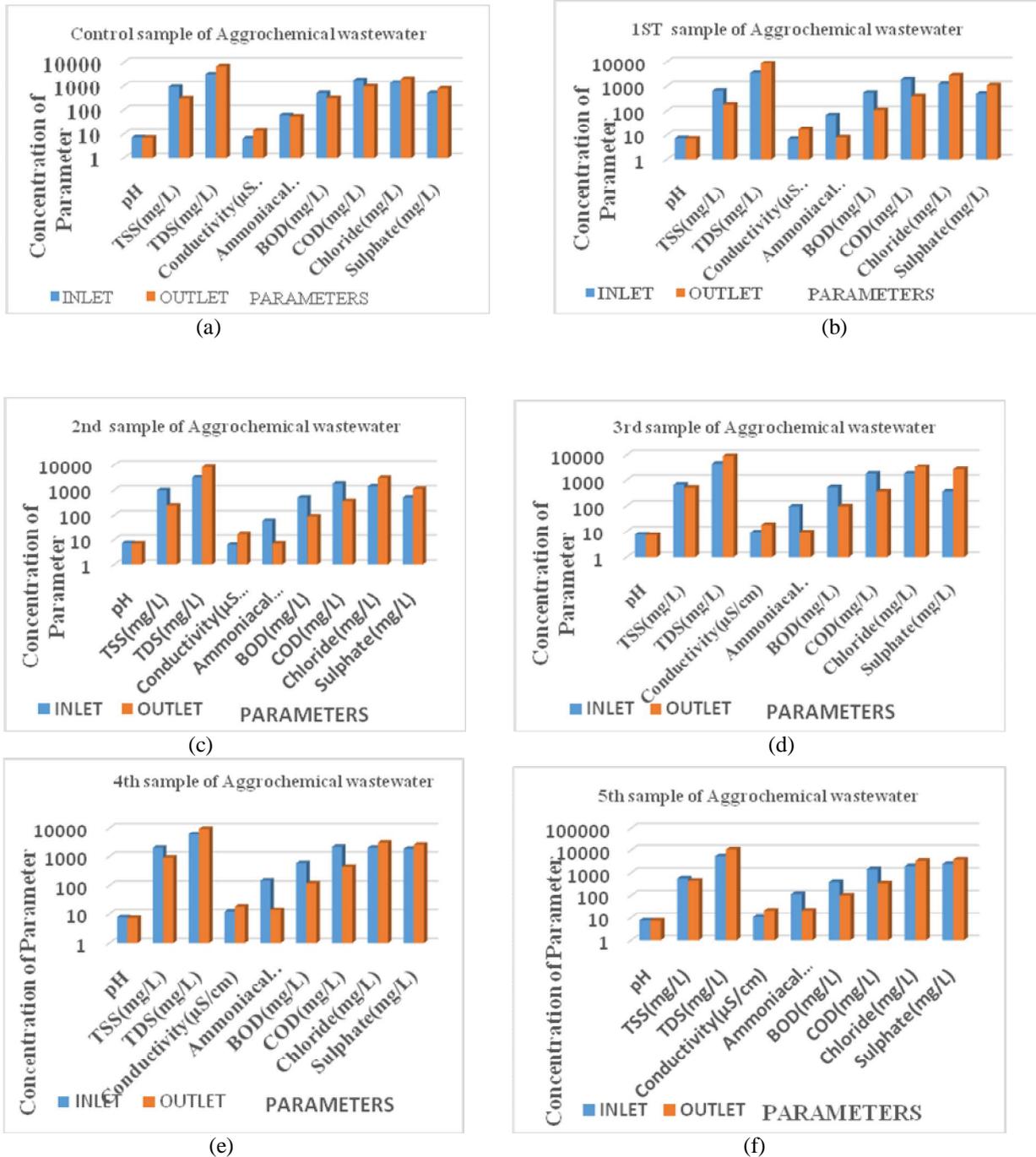


Figure 6: The graphical representation of various Physico –chemical parameters of effluent (a to e)

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Figure 7: Comparison of primary treated effluent and primary treated effluent at 7HRT after treatment of phytoremediation

The quality of soil was found improved. The nitrogen level has increased to 48%. Phosphorus level has increased to 88.57% and level of potash has increased to 17.14% (Table 5, Figure 8). The height and number of Typha Angustifolia increased (Table 6).

Table 5 Soil analysis before and after 5th sampling completion

Sr. no	Parameter	Initial (%) before control	Final (%) after 5 th sampling	% increase
1	Nitrogen	0.50	0.74	48.00
2	Phosphorus	0.35	0.66	88.57
3	Potash	0.70	0.82	17.14

Figure 8 Soil analysis before and after 5th sampling completion

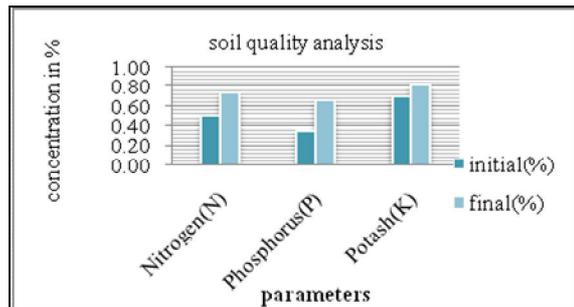


Table 6 Increase in height and Number of Typha Angustifolia

Sr. No.	Sample	No. Of Species	Avg. Height Of Species(cm)
1	Initial	43	12
2	After 1st Sample	55	22
3	After 2nd Sample	68	28
4	After 3rd Sample	77	35
5	After 4th Sample	86	44
6	After 5th Sample	99	53

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IV. RESULT AND ANALYSIS

Table 4 shows Physico-chemical parameters of effluent at 7HRT after treatment of phytoremediation (Typha Angustifolia). The average percent removal of TSS is 49.50%, TDS is (-103.8%), Ammonical nitrogen is 87.8%, B.O.D. is 79.71%, C.O.D. 78.90%, Chloride is (-89%), Sulphate is (-194.47%). The reason of increasing in inorganic compound like TDS, Chloride and Sulphate were due to evaporation of effluent from the surface of top layer of soil of the working model. The average evaporation rate was about 3 to 5 liter per day (Table 2).

V. CONCLUSIONS

1. The subsurface flow (SF) of constructed wetland (CWs) concept can give better removal efficiency for BOD, COD, TSS, Ammonical Nitrogen by using Typha Angustifolia. It is particularly well suited for small to moderate sized installations where suitable land and media are available at a reasonable cost.
2. Maximum reduction efficiency is achieved in Agro chemical Effluent is by Typha Angustifolia, parameters are BOD (82.20%), COD (79.94%), Ammonical Nitrogen (90.16%).
3. Increase in TDS is (-103.8%), Chloride is (-89%) and Sulphate is (-194.47%) due to evaporation of effluent from the surface of top layer of soil of the working model. The average evaporation rate was about 3 to 5 liter per day
4. 7 days retention period of the wastewater are highly significant with increasing the removal efficiency of pollutants based on filtration, degradation and plant uptake mechanisms.
5. In Vertical Flow (VF) CWs moderate to high increase in numbers and heights of plants were found during and at the end of experiment.

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