International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 12 | December - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Experimental study on Physico-chemical Parameters using constructed wetlands for lake water

Harsh Gupta[1] and Prof. Atul Sharma[1]
[1]Department of Civil Engineering, Jabalpur Engineering College, Jabalpur (M.P.)

ABSTRACT

Population growth, agriculture, and industry produce more waste, straining scarce water resources and increasing conflict. This complex, sensitive, and personal issue hit hardest in the summer when local water supplies ran dry. In this paper, we report the results of an experiment we ran using the water grass Phascum australe in several artificial wetland settings. After being drawn from the lake, the raw water is subjected to a series of tests for things like turbidity, total solid, dissolved solid alkalinity, chloride content, phosphate, nitrate, BOD, and COD. Through the wetland treatment, we had successfully eliminated 80% of the turbidity, total solid dissolved solid, phosphate nitrate, and biological oxygen demand (BOD), 65% of the chemical oxygen demand (COD), and roughly 45% of the alkalinity and chloride.

KEY WORD- Experimental process; Constructed wetland; Wastewater Treatment method; Lake Water

1 INTRODUCTION

Water is crucial in shaping the earth and regulating climate. It is one of the most important compounds that has a significant impact on life. People all over the world are in grave danger as a result of unfavorable changes in the physical, chemical, and biological properties of air, water, and soil. Water is highly polluted with various harmful pollutants as a result of population growth, industrialization, and the use of man-made fertilizers. Residents suffer from various water-borne diseases as a result of using contaminated drinking water, so it is necessary to check the quality of drinking water at regular intervals. Water of high quality is essential for disease prevention and overall well-being. Color, temperature, acidity, hardness, pH, sulphate, chloride, dissolved oxygen, bio-oxygen, oxygen, and alkalinity are some of the physical and chemical parameters used in water quality testing.

(Manjare, Vhanalakar, and Muley 2010) This study examines the physico-chemical characteristics of the Tamadalge water tank in Maharashtra's Kolhapur district. Changes in water temperature, light, turbidity, dissolved solids, pH, dissolved oxygen, free carbon, total hardness, chloride, alkalinity, phosphate, and nitrate that occur every month. One of the most crucial elements of an ecosystem is water.

(Popa et al. 2012) This study analyses the chemical properties of five wastewater ponds to determine the degree of wastewater pollution. Over the course of a two-week monitoring campaign, the samples were gathered before being discharged into the Danube. Using potentiometric and spectrophotometric techniques, various organic and inorganic compounds, heavy metals, and biogenic compounds have been analysed. According to test results, wastewater quality varies from location to location and is significantly influenced by the source of the wastewater. To find potential connections between the concentrations of various analysed parameters, correlation analysis was used.

(Patil 2020) people on earth are at great risk due to unwanted changes in the physical, chemical and biological properties of air, water and soil. Due to population growth, industrialization, use of fertilizers and man-made activities, water has become highly polluted with harmful pollutants. Natural water is polluted due to weathering of rocks, sedimentation, mining etc. It is important that the quality of drinking water should be checked from time to time, as the population suffers from various types of water diseases due to the use of contaminated water. Drinking water. congenital disease.(Iram, Kanwal, and Tabassam 2012) Life requires water. Human well-being depends on water quality. Heavy metals occur naturally in low-lying, biologically significant wetlands. Their sources enter natural waters. Gases, soil, minerals, humus, animal waste, and other living things pollute water. (Morhit and Mouhir 2014) We must remember that in general there are three factors that control the aquatic environment, light on the one hand, temperature and depth on the other. Indeed, when light conditions occur first in the life of plants and animals, the temperature adjusts the diffusion of gases (O2 and CO2) in the water and later affects the process of photosynthesis.

Water is very important in shaping the earth and controlling the climate. It is one of the most important compounds that greatly affect health. Due to unwanted changes in the physical, chemical and biological characteristics of air, water and soil, people on earth are at great risk. Due to population growth, industrialization, use of fertilizers and man-made activities, water has become highly polluted with harmful pollutants(Sharma, Walia, and Kumar 2016).(Rahmanian et al. 2015) To protect the public's health, officials in Perak State, Malaysia are looking into the water quality in some unnamed areas to make sure residents always have access to safe water. With this goal in mind, the State conducted in-depth physical and chemical analysis of drinking water samples collected from various locations across the State. Heavy metals like Cu, Zn, Mg, Fe, Cd, Pb, Cr, As, Hg, and the temperature extremes of winter and summer are just some of the variables that can affect water quality. Each water sample taken over time had its Sn content analyzed. Results for each metric are compared to their respective norms.(Sajitha and Vijayamma 2016) This study was designed to assess the water quality of the lake in Athiyanoor Panchayat, Thiruvananthapuram district, Kerala with respect to physico-chemical parameters including temperature, pH, EC (electrical conductivity) is done. TDS (Total Dissolved Solids), TA (Total Alkalinity), DO (Dissolved Oxygen), TH (Total Hardness), NaCl (Salinity), Ca (Calcium), Mg (Magnesium), Cl (Chloride) , Na (Sodium) and K (potassium). The results were evaluated and compared.(Subramani and Jacangelo 2015) All living things on earth need water to live and grow. So far only Earth is the only planet with about 70% water. But due to population growth, industrial development, use of fertilizers in agriculture and human activities, it has been heavily polluted with various harmful pollutants. (Zawude, Samuel, and Asgdom 2020) Composite samples were collected from upstream, midstream and downstream of all land use types. Twenty-three physico-chemical parameters were measured at each sampling site. Temperature, DO, pH, EC, turbidity, width, depth, current speed and discharge are measured locally. Two milliliters of unfiltered water samples were collected from each site for laboratory analysis. NMDS and cluster analysis divided the sites into three groups of land use types.

(Sharma et al. 2020) The process, where people from rural areas migrate to urban areas in search of a brighter future, leading to a large increase in the number of people living in cities, is called urbanization. As a result, the number of cities and towns is growing rapidly. There is great pressure on the depletion of natural resources. As it is, natural resources are facing a serious decline due to the mindless plundering of people. The rate of spread in different regions of the world in the last few decades was unprecedented and unimaginable. In many cities, the rate of infrastructure expansion has not kept pace with the pace of urbanization. (Rahman, Jahanara, and Nahar 2021) factor analysis presented the best fit between the parameters, with four factors explaining 94.29% of the total variance. Cluster analysis showed seasonal variation in surface water quality, often indicating contamination from rainfall or other sources. However, the values of various physico-chemical properties varied according to the season, and the highest values of pollution were recorded in winter.

2 METHODOLOGY

To collect samples, 5 liter plastic bottles with a stopper were used. Each bottle was washed three times with distilled water after being washed with 2% nitric acid. The bottles were then stored in a clean area, filled without leaving an air gap, and then sealed to prevent leakage. DO bottles were used to collect DO sample. Each container was labelled with the sampling name and date. Images and photographs depict a collection of water samples from various lakes. Water samples were analyzed for various parameters in the laboratory of the Pollution Control Board. Several physicochemical parameters were determined for the lake water, including turbidity, total solids, biochemical oxygen demand, chemical oxygen demand, dissolved oxygen, phosphate, alkalinity, and chloride content.

Constructed wetlands use natural processes involving wetland plants, soils, and microbial communities to improve water quality (USEPA). These engineered structures support aquatic plants and controlled flow to use pollutants for phytoremediation. Bacteria, hydraulic retention time, load, temperature, and plant species affect built wetland performance. Small villages are using constructed wetlands to treat wastewater efficiently and cheaply. These systems can be installed in the same area where waste water is generated, maintained by relatively untrained staff, and have low power requirements and low cost.

TABLE 1 SPECIFICATION OF CONSTRUCTED WETLAND MODEL

Sr. No.	Parameter	Specification
1	Method	Plug flow
2	Design flow	Sub surface
3	Size(cm3)	50*30*20
4	Residence time(days)	4
5	Volume (m3)	0.028
6	Diameter of inlet pipe (mm)	1
7	Area of inlet pipe (mm2)	0.785
8	Velocity through pipe (mm/s)	100
9	Plants	water grass, Phragmitiesaustralias
10	Sand:gravel	01:02
11	Soil	Black cotton soil
12	Thickness of the membrance(micron)	20

Figure 1 Primary Planted growth position

Figure 2 Secondary Planted growth position

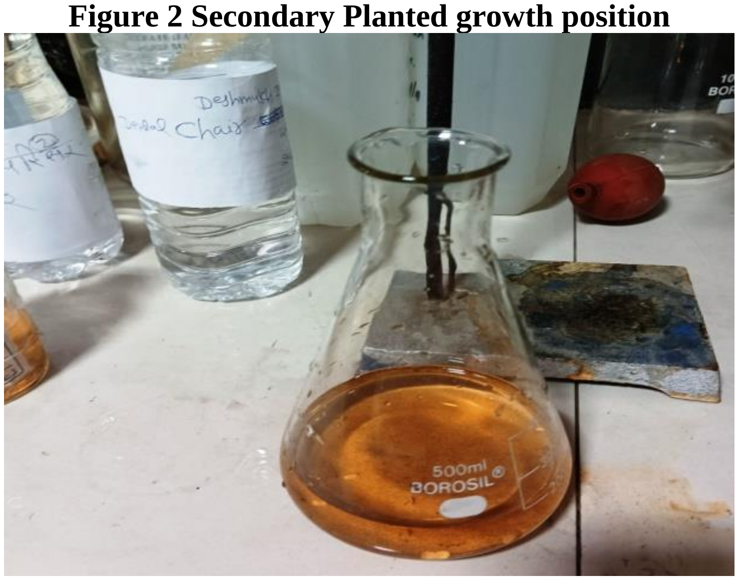

Figure 3 Chemical Testing Stages

Figure 4 C.O. D. Testing Apparatus

Figure 5 B.O. D. Testing Apparatus during Maintained Temperature

3 RESULTS AND DISCUSSION

TABLE 2 TESTING RESULTS OF RAW WATER AND WATER GRASS CONSTRUCTED WETLAND

Sr. No.	Name of test	August Month			September Month		
		Raw water	**First Week**	**Second Week**	**Raw water**	**First Week**	**Second Week**
1	**Turbidity**	20.64	9.3 (55.95%)	4.56 (77.90%)	22.17	5 .2 (76.55%)	3.9 (82.40%)
2	**Total Solid**	506.67	268 (47.10%)	126.52 (75.2%)	554	117 (78.88%)	102.56 (81.48%)
3	**Dissolved Solid**	474.67	216 (54.50%)	100.52 (78.82%)	494	95.42 (80.68%)	91.5 (81.48%)
4	**Alkalinity**	45.34	32 (29.43%)	28 (38.24%)	40.67	24 (40.99%)	22.3 (45.16%)
5	**Chloride Content**	21.9	15 (31.50%)	13.26 (39.45%)	23	12.3 (46.52%)	12.1 (47.39%)
6	**Phosphate**	0.66	0.28 (57.57%)	0.12 (81.81%)	0.587	0.1 (82.96%)	0.08 (86.37%)
7	**Nitrate**	6.9	2.91 (57.82%)	1.32 (80.86%)	4.83	1.29 (73.29%)	1.2 (75.15%)
8	**Biological Oxygen Demand**	11.5	5.72 (50.26%)	2.03 (82.34%)	12.47	1.9 (84.76%)	1.85 (85.16%)
9	**Chemical Oxygen Demand**	44.21	26.72 (39.56%)	14 (68.34%)	39.07	14 (64.16%)	13 (66.72%)

The raw water and water grass constructed wetland testing results are shown in Table 2. During the first and second week of August 2022, the percentage of removals for turbidity testing is 55.95% and 77.90%. During the first and second weeks of September 2022, the percentage of removals from turbidity testing was 76.55% and 82.40%, respectively. The percentage of total solids removed during the first and second weeks of August 2022 was 47.10% and 75.2%, respectively. During the first and second weeks of September 2022, the percentage of total solids removed was 78.88% and 81.48%, respectively. During the first and second weeks of August 2022, the percentage of removals for dissolved solids was 54.50% and 78.82%, respectively. During the first and second weeks of September 2022, the percentage of dissolved solids removed was 80.68% and 81.48%, respectively. The percentage of removals for alkalinity was 29.43% and 38.24% in the first and second weeks of August 2022, respectively. During the first and second weeks of September 2022, the percentage of removals of alkalinity was 40.99% and 45.16%, respectively. During the first and second weeks of August 2022, the percentage of removals for chloride content was 31.50% and 39.45%, respectively. During the first and second weeks of September 2022, the percentage of removals of chloride content was 46.52% and 47.39%, respectively. During the first and second weeks of August 2022, the percentage of removals for phosphate was 57.57% and 81.81%, respectively. During the first and second weeks of September 2022, the percentage of removals of phosphate was 82.96% and 86.37%, respectively. During the first and second weeks of August 2022, the percentage of removals for nitrate was 57.82% and 80.86%, respectively. During the first and second week of September 2022, the percentage of removals of nitrate is

73.29% and 75.15%. During the first and second weeks of August 2022, the percentage of removals for biological oxygen demand was 50.26% and 82.34%, respectively. During the first and second weeks of September 2022, the percentage of removals of biological oxygen demand was 84.76% and 85.16%, respectively. During the first and second weeks of August 2022, the percentage of removals for chemical oxygen demand was 39.56% and 68.34%, respectively. During the first and second weeks of September 2022, the percentage of removals of biological oxygen demand was 64.16% and 66.72%, respectively.

TABLE 3 TESTING RESULTS OF RAW WATER AND PHRAGMITIES AUSTRALIAS CONSTRUCTED WETLAND

Sr. No.	Name of test	August Month			September Month		
		Raw water	**First Week**	**Second Week**	**Raw water**	**First Week**	**Second Week**
1	**Turbidity**	20.64	10.12 (50.96%)	5.32 (74.22%)	22.17	4.1 (81.50%)	3.5 (84.21%)
2	**Total Solid**	506.67	256 (49.47%)	114.74 (77.35%)	554	102.7 (81.46%)	94.5 (82.94%)
3	**Dissolved Solid**	474.67	224 (52.80%)	91.87 (80.64%)	494	87.4 (82.30%)	85.2 (82.75%)
4	**Alkalinity**	45.34	30.5 (32.73%)	30.5 (32.73%)	40.67	27 (33.61%)	25.6 (37.05%)
5	**Chloride Content**	21.9	13.4 (38.82%)	12.65 (42.23%)	23	12.43 (45.95%)	11.9 (48.26%)
6	**Phosphate**	0.66	0.25 (62.12%)	0.17 (74.24%)	0.587	0.12 (79.55%)	0.07 (88.07%)
7	**Nitrate**	6.9	2.35 (65.94%)	1.9 (72.46%)	4.83	1.85 (61.69%)	1.6 (66.87%)
8	**Biological Oxygen Demand**	11.5	4.13 (64.08%)	1.9 (83.47%)	12.47	1.8 (85.56%)	1.4 (88.77%)
9	**Chemical Oxygen Demand**	44.21	23.12 (47.70%)	17.52 (26.69%)	39.07	16.52 (57.71%)	13.4 (65.70%)

Table 3 shows the testing results of raw water and phragmites in Australia's constructed wetland. During the first and second weeks of August 2022, the percentage of removals for turbidity testing was 50.96% and 74.22%, respectively. During the first and second weeks of September 2022, the percentage of removals from turbidity testing was 81.50% and 84.21%, respectively. The percentage of total solids removed during the first and second weeks of August 2022 was 49.47% and 77.35%, respectively. During the first and second weeks of September 2022, the percentage of total solids removed was 81.46% and 82.94%, respectively. The percentage of dissolved solids removed during the first and second weeks of August 2022 was 52.80% and 80.64%, respectively.

During the first and second weeks of September 2022, the percentage of removals of dissolved solids was 82.30% and 82.75%, respectively. During the first and second weeks of August 2022, the percentage of removals for alkalinity was 32.73% and 32.73%, respectively. During the first and second weeks of September 2022, the percentage of removals of alkalinity was 33.61% and 37.05%, respectively. During the first and second weeks of August 2022, the percentage of removals for chloride content was 38.82% and 42.23%, respectively. During the first and second week of September 2022, the percentage of removals of chloride content is 45.95% and 48.26%. During the first and second week of August 2022, the percentage of removals for phosphate is 62.12% and 74.24%. During the first and second week of September 2022, the percentage of removals of phosphate is 79.55% and 88.07%.

During the first and second week of August 2022, the percentage of removals for nitrate is 65.94% and 72.46%. During the first and second week of September 2022, the percentage of removals of nitrate is 61.69% and 66.87%. During the first and second week of August 2022, the percentage of removals for biological oxygen demand is 64.08% and 83.47%. During the first and second week of September 2022, the percentage of removals of biological oxygen demand is 85.56% and 88.77%. During the first and second week of August 2022, the percentage of removals for chemical oxygen demand is 47.70% and 26.69%. During the first and second week of September 2022, the percentage of removals of biological oxygen demand is 57.71% and 65.70%.

TABLE 4 TESTING RESULTS OF RAW WATER AND UNPLANTED CONSTRUCTED WETLAND

Sr. No.	**Name of test**	**August Month**			**September Month**		
		Raw water	**First Week**	**Second Week**	**Raw water**	**First Week**	**Second Week**
1	**Turbidity**	20.64	12.02 (41.76%)	7.26 (64.82%)	22.17	6.2 (72.03%)	5.12 (76.90%)
2	**Total Solid**	506.67	324 (36.05%)	174.25 (65.60%)	554	164 (70.39%)	150 (72.92%)
3	**Dissolved Solid**	474.67	268 (43.53%)	154.23 (67.50%)	494	143.58 (70.94%)	140.9 (71.48%)
4	**Alkalinity**	45.34	33.69 (25.69%)	31.56 (30.39%)	40.67	30.52 (24.95%)	29.3 (27.95%)
5	**Chloride Content**	21.9	17 (22.37%)	15.43 (29.54%)	23	14.95 (35.00%)	14.43 (37.26%)
6	**Phosphate**	0.66	0.38 (42.42%)	0.36 (45.45%)	0.587	0.32 (45.48%)	0.32 (45.48%)
7	**Nitrate**	6.9	5.2 (24.63%)	4.22 (38.84%)	4.83	4.1 (15.11%)	4 (17.18%)
8	**Biological Oxygen Demand**	11.5	9.22 (19.82%)	7.44 (35.30%)	12.47	7.1 (43.06%)	6.9 (44.67%)
9	**Chemical Oxygen Demand**	44.21	32 (27.61%)	21.5 (51.47%)	39.07	21 (20.65%)	19.57 (49.91%)

Table 4 shows the testing results of raw water and unplanted constructed wetland During the first and second week of August 2022, the percentage of removals for turbidity testing is 41.76% and 64.82%. During the first and second week of September 2022, the percentage of removals of turbidity testing is 72.03% and 76.90%. During the first and second week of August 2022, the percentage of removals for total solid is 36.05% and 65.60%. During the first and second week of September 2022, the percentage of removals of total solid is 70.39% and 72.92%.During the first and second week of August 2022, the percentage of removals for dissolved solid is 43.53% and 67.50%. During the first and second week of September 2022, the percentage of removals of dissolved solid is 70.94% and 71.48%.During the first and second week of August 2022, the percentage of removals for alkalinity is 25.69% and 30.39%. During the first and second week of September 2022, the percentage of removals of alkalinity is 24.95% and 27.95%. During the first and second week of August 2022, the percentage of removals for chloride content is 22.37% and 29.54%.

During the first and second week of September 2022, the percentage of removals of chloride content is 35.00% and 37.26%. During the first and second week of August 2022, the percentage of removals for phosphate is 42.42% and 45.45%. During the first and second week of September 2022, the percentage of removals of phosphate is 45.48% and 45.48%. During the first and second week of August 2022, the percentage of removals for nitrate is 24.63% and 38.84%. During the first and second week of September 2022, the percentage of removals of nitrate is 15.11% and 17.18%. During the first and second week of August 2022, the percentage of removals for biological oxygen demand is 19.82% and 35.30%. During the first and second week of September 2022, the percentage of removals of biological oxygen demand is 43.06% and 44.67%. During the first and second week of August 2022, the percentage of removals for chemical oxygen demand is 27.61% and 51.47%. During the first and second week of September 2022, the percentage of removals of biological oxygen demand is 20.65% and 49.91%.

4 CONCLUSIONS

The raw water and water grass constructed wetland testing results are shown in Table 2. The maximum percentage of removals of turbidity, total solid, dissolved solid, alkalinity, chloride content, phosphate content, biological oxygen demand testing are 82.40%, 81.48%, 81.48%, 45.16%, 47.39%,8 6.37% and 85.16% respectively, during the second week of September. The maximum percentages of removals of nitrate testing and chemical oxygen demand are 80.86% and 68.34% respectively during the second week of August. Table 3 shows the testing results of raw water and phragmities australias constructed wetland. The maximum percentage of removals of turbidity, total solid, dissolved solid, alkalinity, chloride content, phosphate content, biological oxygen demand and chemical oxygen demand testing are 84.21%, 82.94%, 82.75%, 37.05%, 48.26%, 88.07%, 88.77% and 65.70% respectively, during the second week of September. The maximum percentage of removals of nitrate testing is 72.46% respectively during the second week of August. Table 4 shows the testing results of raw water and unplanted constructed wetland The maximum percentage of removals of turbidity, total solid, dissolved solid, chloride content, phosphate content, biological oxygen demand testing are 76.90%, 72.92%, 71.48%, 14.43%, 45.48% and 44.67% respectively, during the second week of September. The maximum percentage of removals of alkalinity, nitrate and chemical oxygen demand testing are 30.39%, 38.84% and 51.47% respectively, during the second week of August.

REFERENCES

Iram, Shazia, Sadia Kanwal, and Tauseef Tabassam. 2012. 'Assessment of Physicochemical Parameters of Wastewater Samples'. (May 2018).

Manjare, S. A., S. A. Vhanalakar, and D. V Muley. 2010. 'Analysis Of Water Quality Using Physico-Chemical Parameters Tamdalge Tank In Kolhapur District , Maharashtra .' 1(2):115–19.

Morhit, Mohammed El and Latifa Mouhir. 2014. 'Study of Physico-Chemical Parameters of Water in the Loukkos River Estuary (Larache , Morocco)'. 1–9.

Patil, P. N. 2020. 'Physico-Chemical Parameters for Testing of Water – A Review'. (January 2012).

Popa, Paula, Mihaela Timofti, Mirela Voiculescu, Silvia Dragan, Catalin Trif, and Lucian P. Georgescu. 2012. 'The Cientific WorldJOURNAL Study of Physico-Chemical Characteristics of Wastewater in an Urban Agglomeration in Romania'. 2012.

Rahman, Arafat, Ishrat Jahanara, and Yeasmin Nahar. 2021. 'Assessment of Physicochemical Properties of Water and Their Seasonal Variation in an Urban River in Bangladesh'. Water Science and Engineering 14(2):139–48.

Rahmanian, N., Siti Hajar, Bt Ali, M. Homayoonfard, N. J. Ali, M. Rehan, Y. Sadef, and A. S. Nizami. 2015. 'Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak , Malaysia'.

Sajitha, V. and Smitha Asok Vijayamma. 2016. 'Study of Physico-Chemical Parameters and Pond Water Quality Assessment by Using Water Quality Index at Athiyannoor Panchayath , Kerala , India'. 2:46–51.

Sharma, Rohit, Raghvendra Kumar, Suresh Chandra Satapathy, and Nadhir Al-ansari. 2020. 'Analysis of Water Pollution Using Different Physicochemical Parameters : A Study of Yamuna River'. 8(December):1–18.

Sharma, Vandana, Yogesh Kumar Walia, and Aditya Kumar. 2016. 'Assessment of Physico Chemical Parameters for Analysing Water : A Review'. 2(1):25–33.

Subramani, Arun and Joseph G. Jacangelo. 2015. 'ScienceDirect Emerging Desalination Technologies for Water Treatment : A Critical Review'. Water Research 75:164–87.

Zawude, Berhanu, Bakure Samuel, and Fikadu Asgdom. 2020. 'Analysis of Physicochemical Water Quality Parameters for Streams under Agricultural , Urban and Forest Land ‐ Use Types : In the Case of Gilgel Gibe Catchment , Southwest Ethiopia'. Applied Water Science 10(11):1–8.