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PHYSICO-CHEMICAL PROPERTIES OF TREATED AND UNTREATED WASTE WATER SAMPLES FROM WUPA SEWAGE TREATMENT PLANT IDU ABUJA

Chibueze Charles Okafor[1] and Salaudeen Abdulwasiu Olawale[2]*

[1]Chemistry Dept. University of Abuja, Nigeria.
[2]Applied Mathematics Dept. (Chem. option) National Mathematical Centre, Abuja.

***Corresponding Author: Salaudeen Abdulwasiu Olawale**
Applied Mathematics Dept. (Chem. option) National Mathematical Centre, Abuja.

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ABSTRACT

This Research work was carried out to Compare Treated and Untreated Wastewater samples from Wupa Sewage Treatment Plant Idu Research and Industrial Layout Abuja, Federal Capital Territory (FCT). Samples were collected from the period of June to August 2017. The samples were analyzed for physicochemical parameters using standard analytical procedures. Results obtained in the study revealed that the Untreated wastewater and treated wastewater samples had the following values: the pH values for all the untreated wastewater sample ranged between 7.33-7.56 while that of treated wastewater sample ranged between 7.23-7.31, temperature; 26.60-27.20^{o}C, 26.00-26.90 ^{o}C, electrical conductivity; 277.00-349.00 µS/cm, 244.00-307.00 µS/cm, turbidity; 188.00-435.00 NTU; 6.00-9.10 NTU, total dissolved solids; 162.00-180.00 mg/l, 132.00-158.00 mg/l, total suspended solids; 134.50-160.00 mg/l, 7.80-14.50 mg/l, total solids; 298.00-325.00 mg/l, 140.80-169.60 mg/l, dissolved oxygen; 2.00-3.60 mg/l, 6.00-6.90 mg/l, biochemical oxygen demand; 120.00-140.00 mg/l, 134.50-160.00 mg/l, chemical oxygen demand; 160.00-290.00 mg/l, 7.00-10.00 mg/l and total alkalinity; 45.80-68.00 mg/l, 40.00-55.00 mg/l for untreated and treated waste waters respectively. Thus the Wupa Sewage Treatment Plant Idu Research and Industrial Layout Abuja had a significant role in the control of pollution loads of wastewater and its quite effective.

KEYWORDS: Wastewater, pH, temperature, treated, untreated.

INTRODUCTION

Water is abundant on the planet as a whole, but fresh potable water is not always available at the right time or the right place for human or ecosystem use. It is undoubtedly the most precious natural resource vital to life (Fakayode, 2005). Rivers are open systems, which have come under increasing pressure from human activities often affecting their ecological integrity over the last century throughout the world (Ajayi and Osibanjo, 1981). Over the last years in many countries, there has been a considerable population growth accompanied by a large increase in rural urban drift and industrial growth. This has led to massive pollution due to improper management of vast amount of wastes generated by various anthropogenic activities (Olawale, 2016). Industrial discharges into river are one of the causes of irreversible degradation occurring in surface water system. Due to their role in carrying industrial wastewaters, rivers are among the most vulnerable water bodies to pollution. There has been significant impairment of river with pollutants, rendering the water unsuitable for beneficial purposes. Water resource of our planet is one of the most important needs for human existence and about 2.7 % of earth's water is consumable and this is threatened by pollution. Pollution as viewed by Omoleke (2004), is the environmental alteration due to man's activities detrimental to most indigenous life. There is need to have effective methods of treating these polluted water. Therefore, this research is aimed at comparing physical and chemical properties of treated and untreated wastewater from Wupa sewage treatment plant in Federal Capital Territory (FCT) Abuja.

MATERIALS AND METHODS

Sample Location

Wupa Sewage Treatment Plant is located at Cadastral Zone Institute and Research District of Abuja FCT. The study area lies between latitude 7^{o} 20^{1} and 9^{o} 20^{1} N and longitude 6^{o} 45^{1} and 7^{o} 39^{1}E.

Figure 1: Google image of the treatment plant.

Sample Collection

Samples were collected each for Untreated and Treated wastewater from the period of June to August 2017 with pre-washed 4 litres keg each, at (influent) point of high turbulence flow to ensure good mixing, just as it was discharged into the sewage treatment plant and treated wastewater (effluent) before it was discharged into the Wupa river.

Sample Preservation

The samples were placed in cooler to prevent change in the composition of the samples. The wastewater samples were further placed in the refrigerator on getting to the laboratory as prescribed by APHA, (1998) and Aiyesanmi (2006, 2008).

- Samples for general physicochemical parameters were stored in the pre-washed 2 litres keg;
- Samples for COD were put separately in the pre-washed 250 ml brown bottle and fixed with Analar grade H_2SO_4;
- Samples for BOD_5 determination were put in the BOD bottle and wrapped with aluminium foil. All samples were properly labelled.

Methods of Analysis

Standard analytical methods prescribed by APHA, 2005 and Ademoroti, 1996a and 1996b were employed.

RESULTS AND DISCUSSIONS

The results of the physicochemical parameters of the untreated and treated wastewater from Wupa sewage treatment plant from June to August 2017 are described below. The values obtained for pH, temperature, turbidity, conductivity, total dissolved solids, total solids, biological oxygen demand, chemical oxygen demand, dissolved oxygen and total alkalinity are given in the tables below.

Table 1: Characteristics of untreated and treated water samples for week one.

Parameters	Untreated Wastewater	Treated Wastewater
pH	7.33	7.23
Temperature (^oC)	26.80	26.00
Conductivity (µS/cm)	308.00	286.00
Turbidity (NTU)	435.00	6.40
TS (mg/l)	325.00	158.50
TDS (mg/l)	165.00	144.00
D.O (mg/l)	2.60	6.70
BOD (mg/l)	130.00	3.00
TSS (mg/l)	160.00	14.50
COD (mg/l)	160.00	8.00
Total Alkalinity (mg/l)	67.50	45.80

Table 2: Characteristics of untreated and treated water samples for week two.

Parameters	Untreated Wastewater	Treated Wastewater
pH	7.42	7.25
Temperature (^{o}C)	27.10	26.10
Conductivity (µS/cm)	349.00	301.00
Turbidity (NTU)	321.00	8.10
TS (mg/l)	316.60	169.00
TDS (mg/l)	176.00	158.00
D.O (mg/l)	3.00	6.60
BOD (mg/l)	130.00	4.00
TSS (mg/l)	140.60	11.60
COD (mg/l)	250.00	10.00
Total Alkalinity (mg/l)	70.00	47.00

Table 3: Characteristics of untreated and treated water samples for week three.

Parameters	Untreated Wastewater	Treated Wastewater
pH	7.56	7.30
Temperature (^{o}C)	26.92	26.80
Conductivity (µS/cm)	288.00	248.00
Turbidity (NTU)	189.00	6.00
TS (mg/l)	298.00	140.80
TDS (mg/l)	162.00	133.00
D.O (mg/l)	3.20	6.90
BOD (mg/l)	140.00	4.00
TSS (mg/l)	136.00	7.80
COD (mg/l)	290.00	10.00
Total Alkalinity (mg/l)	65.00	55.00

Table 4: Characteristics of untreated and treated water samples for week four.

Parameters	Untreated Wastewater	Treated Wastewater
pH	7.36	7.23
Temperature (^{0}C)	26.60	26.00
Conductivity (µS/cm)	304.00	287.00
Turbidity (NTU)	220.00	9.10
TS (mg/l)	316.00	161.50
TDS (mg/l)	166.00	147.00
D.O (mg/l)	2.90	6.50
BOD (mg/l)	140.00	3.00
TSS (mg/l)	150.00	14.50
COD (mg/l)	290.00	7.00
Total Alkalinity (mg/l)	65.80	40.00

Table 5: Characteristics of untreated and treated water samples for week five.

Parameters	Untreated Wastewater	Treated Wastewater
pH	7.44	7.26
Temperature (^{0}C)	27.20	26.60
Conductivity (µS/cm)	345.00	307.00
Turbidity (NTU)	320.00	7.00
TS (mg/l)	320.00	169.30
TDS (mg/l)	180.00	158.00
D.O (mg/l)	2.00	6.40
BOD (mg/l)	120.00	3.00
TSS (mg/l)	140.80	11.30
COD (mg/l)	250.00	7.00
Total Alkalinity (mg/l)	45.80	40.00

Table 6: Characteristics of untreated and treated water samples for week six.

Parameters	Untreated Wastewater	Treated Wastewater
pH	7.54	7.31
Temperature (^{o}C)	26.99	26.90
Conductivity (µS/cm)	277.00	244.00
Turbidity (NTU)	188.00	6.60
TS (mg/l)	300.50	141.00
TDS(mg/l)	166.00	132.00
D.O (mg/l)	3.60	6.00
BOD (mg/l)	130.00	5.00
TSS (mg/l)	134.50	9.00
COD (mg/l)	260.00	10.00
Total Alkalinity (mg/l)	68.00	46.0

Table 7: Mean values of physicochemical parameters .

Parameters	Untreated wastewater	Treated wastewater
pH	7.44 ± 0.09	7.26 ± 0.05
Temperature (^{0}C)	26.94 ± 0.19	26.5 ± 0.37
Conductivity (µS/cm)	311.83 ±26.89	278.83 ± 24.38
Turbidity (NTU)	278.83± 89.11	7.2 ± 1.07
TS (mg/l)	312.82 ±10.07	156.78 ± 11.91
TDS (mg/l)	169.16± 6.49	135.33 ± 10.45
D.O (mg/l)	2.88 ± 0.49	6.51 ± 0.28
BOD (mg/l)	130.00± 8.16	3.67 ± 0.75
TSS (mg/l)	143.65± 8.83	11.45 ± 2.52
COD (mg/l)	250.00 ±43.59	8.67 ± 1.37
Total Alkalinity (mg/l)	63.83 ± 8.19	45.63 ± 5.05

DISCUSSION

pH

pH values for all the untreated wastewater ranged from 7.33-7.56 with a mean value of 7.44±0.09 while that of treated wastewater obtained ranged from 7.23-7.31 with a mean value of 7.26±0.05. There were slight variations in the weekly results obtained for pH, but week three and six revealed higher values as shown in Table 3 and 6 for the untreated wastewater. pH of water affects the solubility of many toxic and nutritive chemicals; therefore, the availability of these substances to aquatic organisms is affected. The pH of wastewater needs to remain between 6 and 9 to protect and be beneficial to organisms (USEPA, 2004), and also 7 for drinking water (WHO, 1996). Aquatic organisms are very sensitive to pH changes in their environment because their metabolic activities are pH dependent. The results for pH in this study were slightly higher than the neutral pH but within the permissible standards of NESREA and WHO of 6 – 9 and 6.5 – 8.5, respectively. Hence the pH of the wastewater poses no threat to the aquatic organisms and the people using Wupa River. Similar result was recorded by Ogbu *et al.* (2013) while investigating physicochemical characteristics of Ama brewery effluent and it's receiving Ajali River in Udi, Enugu state, Nigeria.

Temperature

Temperature values obtained for untreated wastewater ranged from 26.60 ^{o}C−27.20^{o}C with a mean value of 26.94^{o}C±0.19^{o}C, while that of treated wastewater ranged from 26.00 ^{o}C−26.90 ^{o}C with a mean value of 26.5±0.37 ^{O}C. There were slight variations in the weekly results recorded for temperature for the untreated wastewater with week two and five having higher values as shown in Table 2 and 5 for the untreated wastewater while the variation for the weekly result obtained for the treated wastewater was not as much. Metabolic rate and the reproductive activities of aquatic life are controlled by water temperature. An increase in stream temperature also causes a decrease in dissolved oxygen, limiting the amount of oxygen available to aquatic organisms. With a limited amount of dissolved oxygen available, the fish in this system will become stressed. A rise in temperature can also provide conditions for the growth of disease-causing organisms. All the temperature results recorded in this study were within the NESREA (2009) standards for effluent discharges to surface water. However, similar result was recorded (Akpen *et al.*, 2016) while evaluating the effects of sewage effluent discharges on the water quality of wupa river in Abuja, Nigeria.

Electrical Conductivity (EC)

Electrical Conductivity values obtained for untreated wastewater ranged from 277.00−349.00 µS/cm with a mean value of 311.83 ±26.89 µS/cm, while that of the treated wastewater ranged from 244.00−307.00 µS/cm with a mean value of 278.83±24.38 µS/cm. According to Olawale, 2016 conductivity reflects the status of inorganic pollution and is a measure of total dissolved

solid and ionized species in the water. Variation in conductivities observed suggest that considerable amount of dissolved ionic substances enter the river due to indiscriminate dumping of wastes.

Turbidity

Turbidities of 10 NTU or less represent very clear waters; 50 NTU is cloudy; and 100-500 NTU or greater is very cloudy to muddy. Some fish species may become stressed at prolonged exposures of 25 NTUs or greater (Barnes, 1998). In the present study, the turbidity of the treated water (outlet) decreased to between 6.00−9.10 NTU with a mean value of 7.20 NTU ±1.07 NTU from its 188.00−435.00 NTU initial (Inlet) level.

Total Solid (TS)

Total Solid values for untreated wastewater ranged from 298.00−325.00 mg/l with a mean value of 312.82±10.07 mg/l, while that of the treated wastewater ranged from 140.80−169.60 mg/l with a mean value of 156.78±11.91 mg/l. High level of TS is known to reduce the clarity of water.

Total Dissolved Solid (TDS)

Total Dissolved Solid values obtained for untreated wastewater ranged from 162.00−180.00 mg/l with a mean value of 169.16±6.49 mg/l, while that of the treated wastewater ranged from 132.00−158.00 mg/l with a mean value 145.33±10.45 mg/l. The palatability of water with a TDS level of less than 600 mg/l is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/l. The presence of high levels of TDS may also be objectionable to consumers, owing to excessive scaling in water pipe, heaters, boilers and household appliances.

Total Suspended Solid (TSS)

Total Suspended Solid value for untreated wastewater ranged from 134.50−160.00 mg/l with a mean value of 143.65±8.82 mg/l while that of the treated wastewater ranged from 7.80−14.50 mg/l with a mean value of 11.45±2.52 mg/l. There were variations in the weekly results recorded for TSS for the untreated wastewater, but week one and four showed a higher value as shown in Table 1 and 4 for the untreated wastewater while there were also variations for the weekly results obtained for the treated wastewater. The reduction in the values obtained is an indication that the treatment plant is efficient. The results obtained for the treated wastewater were within permissible standard of NESREA, (2009). While that of the untreated were above the permissible standard of NESREA, (2009).

Jamrah *et al*. (2008b) reported 84 and 100% removal efficiency of TSS in a settling tank installed in a treatment plant. Removal levels of TSS were found to be associated with the anoxic good settling characteristics of sludge were obtained throughout the treatment and the problem of sludge bulking or foaming was absent. Katayon *et al*. (2008) also reported 50-88% removal of TSS in domestic wastewater using subsurface constructed wetlands in Malaysia.

Total Alkalinity

Alkalinity is the capacity to neutralize acids and the alkalinity of natural water is result mainly from the salts of weak acids. Total Alkalinity concentrations obtained for untreated wastewater ranged from 45.80−68.00 mg/l with a mean value of 63.83±8.19 mg/l, while that of the treated wastewater ranged from 40.00−55.00 mg/l with a mean value of 45.63±5.05 mg/l. There were variations in the weekly results recorded for total alkalinity for the untreated wastewater with week two and six having the highest values as shown in Tables 4.2 and 4.6 for the untreated wastewater. Alkalinity itself has little public health significance, although highly alkaline waters are unpalatable and can cause gastrointestinal discomfort. Since alkalinity is pH dependent, the higher values recorded for untreated wastewaters are expected. The mean alkalinity agreed with the values documented by Boyd (1995) for natural water.

Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

Dissolved Oxygen values obtained for untreated wastewater ranged from 2.00−3.60 mg/l with a mean value of 2.88±0.49 mg/l, while that of the treated wastewater ranged from 6.00−6.90 mg/l with a mean value of 6.51±0.28 mg/l. DO is essential for fish to breathe. Many microbial forms require it, as well. The low solubility of oxygen in water means that it does not take much oxygen-consuming material to deplete the DO. High levels of DO are necessary for fish respiration. The DO values for the untreated wastewater were below WHO recommended levels of 5.0 mg/l, while DO values for the treated wastewater were within the permissible standard levels (WHO, 1996).

Biochemical Oxygen Demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions while Chemical Oxygen Demand (COD) is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water.

The BOD and COD of the untreated wastewater recorded were 120.00−140.00 mg/l and 160.00−290.00 mg/l respectively. The level of BOD and COD decreased after treatment to 3.00−5.00 mg/l and 7.00−10.00 mg/l respectively. The values of BOD and COD decreased significantly indicating the efficiency of the treatment plant. Katayon *et al*. (2008) reported 56-77% removal of COD in domestic wastewater using subsurface constructed wetlands in Malaysia.

CONCLUSION

The results for this study revealed that the physicochemical parameters of the wastewater samples analyzed after treatment were lower than the untreated wastewater samples. From the results obtained it could be concluded that the sewage treatment plant is effective in the treatment of the studied parameters. Hence the effluent from the plant can safely be discharged into Wupa River.

REFERENCES

1. Ademoroti CMA. Environmental chemistry and toxicology. Foludex press Ltd. Ibadan, Nigeria, 1996a.
2. Ademoroti CMA. Standards methods for water and effluents analysis. Foludex press Ltd. Ibadan, Nigeria, 1996b.
3. Ajayi SO, Osibanji O. "Pollution studies on Nigeria Rivers 11; Water quality of some Nigerian Rivers". *Environ. Pollut. Series*, 1981; 2: 87-95.
4. Aiyesanmi AF. "Baseline concentration of heavy metals in water samples from river within Okitipupa southeast belt of Nigeria bituminous field". *J. Chem. Soc. Nigeria*, 2006; 31(1&2): 30-37.
5. Aiyesanmi AF. "Baseline heavy metals concentration in river sediments within Okitipupa south east belt of Nigeria bituminous sand field". *J. Chem. Soc. of Nig*, 2008; 33(2): 29-41.
6. Akpen GD, Ekanem EJ, Agunwamba JC. "Effects of sewage effluent discharges on The water quality of wupa river in abuja, Nigeria". *Journal of Science and Technology*, 2016; 36(2): 85-95.
7. APHA. Standard methods for the examination of water and wastewater, 20th ed. American Public Health Association, American water works Association, Water Pollution Control Federation, Washington, USA, 1998.
8. APHA. Standard methods for the examination of water and waste water, 21st edition Washington, DC, American public Health Association, 2005.
9. Barnes KH, Meyer JL, Freeman BJ. "Sedimentation and Georgia's Fishes, An analysis of existing information and future research". *1997 Georgia Water Resources Conference, March 20-22, 1997, the University of Georgia, Athens Georgia*, 1998.
10. Boyd CE. Water Quality in warm water fish ponds. *Auburn University*. 359 Craftmaster printers, Ine. Oplika, Alabama: 1995.
11. Fakayode SO. "Impact assessment of industrial effluent on water quality of the receiving Alaro river in Ibadan Nigeria". *AJEAM-RAGEE*, 2005; 10: 1-13.
12. Jamrah A, Al-Futaisi A, Prathapar S, Al-Harrasi A. "Evaluating greywater reuse potential for sustainable water resources management in Oman". *Environ. Monit. Assess*, 2008; 137: 315-327.
13. Katayon S, Fiona Z, Megat MJ, Mohd Noor, Abdul-Halim G, Ahmad J. "Treatment of mild domestic wastewater using subsurface constructed wetlands in Malaysia". *Int. J. Environ. Stud*, 2008; 65: 87-102.
14. NESREA. National Environmental Standards and Regulation Enforcement Agency (NESREA) Regulations. Volume 96, Number 65, The Federal Government Printer, Abuja, Nigeria, 2009.
15. Ogbu KC, Ebenebe CI, Abajue MC. "Physicochemical Characteristics of Ama Brewery Effluent and its Receiving Ajali River in udi, Enugu state, Nigeria". *Animal Research International*, 2008; 13(2): 2392-2399.
16. Olawale SA. 2016 "Physico Chemical Analysis of Water from Asa River, Ilorin, Nigeria". *Imperial Journal of Interdisciplinary Research*, 2016; 2(3): 119-126.
17. Omoleke II. "Management on environmental pollution in Ibadan, an Africa city: The challenges of health hazard facing government and the people". *Journal of Human Ecology*, 2004; 15(4): 265-275.
18. USEPA. Memorandum: Development and Adoption of Nutrient Criteria into Water Quality Standards. United State Environmental Protection Agency, Washington DC, USA, 2004.
19. WHO. Guideline for Drinking Water Quality. 2nd Edition, Volume 2, Health Criteria and Other Supporting International Programme on Chemical Safety, World Health Organization, Geneva, 1996.