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Article · March 2017

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Physico-Chemical Properties of Wastewater within Agbara and Impact on Ologe Lagoon, Lagos.

Abayomi David Folawewo, M.Sc.[1*]; Alexander Nnamdi Madu, Ph.D.[1]; Adekemi Omolayo Faboyede, Ph.D.[2]; and Olaitan Bamidele Muyideen. M.Sc.[3]

[1]Department of Industrial Chemistry, Crawford University, Igbesa, Ogun State, Nigeria.
[2]Department of Biological Sciences, Crawford University, Igbesa, Ogun State, Nigeria.
[3]Department of Chemistry, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

E-mail: yfolawewo@yahoo.com*

ABSTRACT

The physico-chemical analysis of effluents from diverse factories in Agbara and the fresh water bodies receiving these effluents in Ogun State, Nigeria was carried out to establish the effect of the effluents. The study analyzed the effect of industrial effluent discharge on Ologe Lagoon.

Sampling points; W3, W4, W5, W6, and W7 were effluents discharged directly from the factories located within Agbara industrial estate. Sampling points W1 to W7 were chosen along the water body before and after discharged of these effluents to reflect the contribution and the effect of the industrial and domestic effluents. The study revealed that BOD values were 13.04, 75.99, 13.04, 16.48, 14.92, 14.37 and 14.82 for sample W1, W2, W3, W4, W5, W6, and W7, respectively.

Except for sample W7, all pH values were all in the basic region with conductivity ranging from 64 µs/cm to as high as 631 µs/cm. The total hardness value ranges from 1.83 to as high as 6.50 whereas the calcium hardness ranges from 0.25 to 1.63. The mean concentration of heavy metals ranges from 2.01ppm – 7.60 ppm, 0.45-1.42 ppm, and 3.0-8.0 ppm for Cu^{2+}, Fe^{2+}, Pb^{2+}, Cr^{2+} and Zn^{2+} respectively. With the exception of zinc and iron, the discharge of copper exceeded the maximum permissible limit given by the Federal Environmental Protection Agency of Nigeria (FEPA) and WHO. Similarly, mean level of total suspended solids (TSS), values are 700 mg/L, 1700 mg/L, 2200 mg/L, 200 mg/L, 400 mg/L, 1600 mg/L and 900 mg/L for samples W1, W2, W3, W4, W5, W6, and W7, respectively while for total dissolved solids (TDS) the values are 50 mg/L, 70 mg/L, 40 mg/L, 830 mg/L 10 mg/L, 110 mg/L and 160 mg/L for samples W1, W2, W3, W4, W5, W6, and W7, respectively.

There is need for pre-treatment to be carried out on industrial effluent before discharge into water bodies, without this, there is tendency of these pollutants to persist in the water and its uptake may cause long term health problems to living things.

(Keywords: industrial effluent discharge, heavy metals, river pollution)

INTRODUCTION

Rapid population growth in Sub-Saharan Africa has brought about a tremendous increase in urbanization with attendant increase in the volume of domestic and industrial wastewater. Water pollution is primarily associated with domestic and industrial waste (Andreen, 2003).

Water serves as a significant utility in irrigation of agricultural lands, generation of hydro-electric power, municipal water supply, fishing, boating and body-contact recreation, communication as well as unending domestic activities of man and animals (Chapman, 1996). It also serves as a receiver of industrial waste, domestic waste and wastewater resulting from other uses of water (Chapman, 1996). Environmental deterioration is then a natural outcome of rapid population growth, agricultural practices, industrialization and urbanization of society (Teri, 2000).

Industrial wastes are complex mixture of different contaminants or pollutants (Oyewo, 1998). Just as these contaminants or pollutants are different so are their effects on the receiving environment and the biota. Most water bodies in Lagos State, south-western Nigeria, serve as sinks for the disposal of waste from about 2000 medium- and

large-scale industries in urban centers (Anetekhai *et al*., 2003).

Ologe Lagoon receives industrial effluent throughout the year from the neighboring Agbara Industrial Estate, where pharmaceutical, brewery, glass, paint and other industries operate (Kusemiju *et al*., 2001).

Elevated blood lead level was reported among Nigerians due to exposure to the environmental pollutant through various sources (Packham, 1990). Industrial wastewater originates from the wet nature of most large industries which require large quantities of water for processing and disposal of wastes. Most industries are therefore, located near water sources. The pollution potential of industrial wastewater is far greater than that of domestic wastewater. Tannery wastewater, for example, has a BOD of 2500 – 3000 mg/L which is 10 times the strength of domestic wastewater. In the tannery industry, the production of 1ton of hides per day requires a water consumption of about 50 m^3 (Kaul *et al*., 2005).

Both types of wastewater pose threats to water quality which may be classified into health hazards and sanitary nuisances. In most parts of Sub-Saharan Africa, people have no access to potable water. Consequently, raw water from polluted rivers and streams form the major source of utilized water. A study on water quality of Ogun River (Nigeria) was conducted, in which industrial effluents from Lagos and Abeokuta are discharged, it was reported that the level of turbidity, oil and grease, fecal coliform and iron were very high in all the sampling sites (Jaji *et. al;* 2007).

While industrialization is expected, various devastating ecological and human disasters which have continuously occurred over the years implicated industries as major contributors to environmental degradation and pollution processes of various magnitudes. World Bank reported that about 19,000 tons of hazardous waste is produced annually in Nigeria and the waste comes mainly from steel, metal processing, pharmaceuticals, textiles, tanneries, and oil refining industries (Egbu, 2000).

Major industries in Agbara industrial estates are textiles, food, glass, chemicals, pharmaceuticals, allied iron and steel. The indiscriminate discharge of chemical toxins especially, Pb, Cd, Cr, Co, etc. into the environment ensure their transfer into plants, animals and man. High concentration of heavy metals in irrigation waters could results in death of crops, interfere with uptake of other essential nutrients or form objectionable deposits on fruits and render the edible portion of plants toxic to human and grazing animals (Dan'azumi, 2010). Also groundwater contamination with arsenic was observed from tubewells in Behala, Calcutta, India, due to the dumping of arsenic waste by a local factory. This find its way into the groundwater. Arsenic toxicity was noticed among people living in the mentioned area (Chatterjeea *et. al*., 1993). Therefore, the accurate determinations of water quality using the physico-chemical parameters and heavy metals pollution are of ultimately important for controls of pollution. Hence, this study aims at providing additional information to existing data on water quality assessment of this water body.

MATERIALS AND METHODS

Sampling Program

Sampling points selected as station W1 to W7 [W1 (Latitude 6^0 29' 50.47", Longitude 3^0 6' 29.4", Elevation 29.9 feet), W2 (Latitude 6^0 27' 26.78" Longitude 3^0 05' 29.4" Elevation 51.0 feet), W3 (Latitude 6^0 29' 57.0" Longitude 3^0 05' 17.9" Elevation 94.7 feet), W4 (Latitude 6^0 30' 08.6" Longitude 3^0 05' 31.1", Elevation 104.3 feet), W5 (Latitude 6^0 30' 18.3", Longitude 3^0 05' 29.4" Elevation 118.2), W6 (Latitude. 6^0 30' 21.2", Longitude 3^0 05' 46.0" Elevation 87.2 feet) and W7 (Latitude. 6^0 30' 09.0" Longitude. 3^0 05' 48.0" Elevation 99.8 feet)] where wastewaters are discharged into the Lagoon and directly from the factory were noted.

Two points designated as W1, upstream and station W2, downstream along the Lagoon were selected. Station W1 is a point upstream before effluent from Agbara industries starts polluting the Lagoon and station W2, downstream, at the point after the discharge of effluent into the Lagoon. All other samples (W3 to W7) were water effluents discharged directly from factories within Agbara. A total of seven samples were collected for each test. The tests were performed in accordance with APHA method, (1998). The tests were performed in the months of April and May, during dry season, when the river flow is lowest, the level of dilution is little, and pollutants concentration in the river is critical.

LABORATORY ANALYSIS

Five metals namely copper (Cu), iron (Fe), Chromium (Cr), Lead (Pb) and Zinc (Zn) were analyzed in the effluent sample according to standard analytical methods (APHA, 1998). Briefly, 100 mL of the effluent was digested by heating with concentrated HNO_3, and the volume reduced to 3-5 mL. This volume was made up to 10 mL with 0.1N HNO_3. Concentrations of the metals were estimated by using an Atomic Absorption Spectrophotometer Perkin Elmer E. Analyst, 2000, USA.

Two sets of containers were used; the first portion was for the analysis of TSS, TDS, pH and Conductivity. For the first portion, the containers were washed with detergent and rinsed a number of times with the sample to be measured. For the TSS test; the settleable solids were removed first and the TSS was determined. 100 mL of the supernatant was passed through a 0.45 µm pore pre-weighted filter paper and the final mass of the filter paper after oven drying at temperature of 103 ^{0}C-105 ^{0}C was measured and the TSS (in mg/L) calculated. 50 mL of the filtrate from the TSS test was measured and poured into an initially pre-weighted evaporating dish in order to carry out the TDS test.

The sample was evaporated to dryness and the mass of the dish measured and recorded. The TDS (in mg/L) was then calculated (APHA, 1998). Jenway 3320 digital pH meter was used for pH determination. The electrode of the meter was rinsed with distilled water and buffers of pH5, pH7 and pH9 were used to calibrate the meter. The electrode was again rinsed with distilled water and dipped into the sample to be measured. The meter was allowed to stabilize and the pH of the sample was read and recorded. DREL 5 Hach conductivity meter was used for the conductivity measurement. The meter was set to condition mode and was standardized with distilled water in accordance with the instruction manual. The electrode was inserted into the sample and the conductivity reading was recorded.

The second portion of the containers was set aside for metals analysis. Samples for heavy metals analysis were collected in 120 mL plastic container which were initially washed with detergent and rinsed with distilled water. The containers were finally rinsed with 20% Nitric acid before sampling. The samples were preserved by adding 1.5 mL of conc. HNO_3 to each 1 liter of sample and the pH adjusted to 2.0 by the use of pH meter. The samples were necessary, for subsequent analysis. As samples may contain particulate or organic materials, pretreatment in the form of digestion is required before analysis. Nitric acid digestion was employed in accordance with APHA method (1998). The digested sample was taken for Atomic Absorption Spectrophotometer (AAS) analysis (Skoog *et al.,* 1998 and Bader, 2011).

Figure 1: The Study Area showing Agbara Industrial Area and Ologe Lagoon (Google Maps).

RESULTS AND DISCUSSIONS

Table 1: Result of Parameters before Pollution of Ologe Lagoon.

Parameter	Mean Concentration Sample W1	Maximum Permissible Limit	
		FEPA*	WHO*
TSS (mg/mL)	50	10	10
TDS (mg/L)	700	-	500
Conductivity (micromhos/cm)	475	-	-
Alkaliniy (mg/100mL $CaCO_3$)	65.7	-	-
Hardness (mg/mL)	25.0		
BOD	13.04	-	-
pH	7.63	-	6.5-8.5
Copper (mg/L)	3.00	1.00	1.00
Iron (mg/L)	2.01	0.30	0.30
Zinc (mg/L)	0.41	-	5.00
Lead (mg/mL	0.52	1.0	1.0
Chromium (mg/mL)	2.00	1.0	1.0

*FEPA and WHO maximum acceptable limits

Table 2: Result After Industrial Effluent is Discharged into the Lagoon.

Parameter	Mean Concentration Sample W2	Maximum Permissible Limit	
		FEPA*	WHO*
TSS (mg/mL)	70	10	10
TDS (mg/L)	1700	-	500
Conductivity (micromhos/cm)	509	-	-
Alkaliniy (mg/100mL $CaCO_3$)	70.8	-	-
Hardness (mg/mL)	26.7	-	50
BOD	75.99	-	-
pH	8.0	-	6.5-8.5
Copper (mg/L)	3.1	1.00	1.00
Iron (mg/L)	2.10	0.30	0.30
Zinc (mg/L)	0.43	1.00	5.00
Lead (mg/Ml	0.65	1.0	1.0
Chromium (mg/mL)	0.48	0.05	0.05

*FEPA and WHO maximum acceptable limits

Table 3: Results of Effluent from Different Factories.

Parameter	Mean Concentration Samples					Maximum Permissible Limit	
	W3	W4	W5	W6	W7	FEPA*	WHO*
TSS (mg/mL)	40	830	10	110	160	30	-
TDS (mg/L)	2200	200	400	1600	900	2000	-
Conductivity (micromhos/cm)	631	064	160	191	293	600	500
Alkaliniy (mg/100mL $CaCO_3$)	73.9	85.3	71.0	77.0	67.0	-	-
BOD	13.14	16.48	14.92	14.37	14.82	-	-
Hardness (mg/mL)	65.0	30.0	26.6	18.3	36.7		
pH	8.13	7.05	8.11	8.10	5.98	6-9	-
Copper (mg/L)	4.00	4.20	5.00	6.00	8.00	1.0	0.5
Iron (mg/L)	2.64	2.18	4.19	6.07	7.56	20	15
Zinc (mg/L)	0.44	0.84	0.42	0.43	0.84	1.0	1.0
Lead (mg/mL	1.31	1.16	0.71	0.68	0.92	1.0	1.0
Chromium (mg/mL)	2.35	2.68	2.16	2.01	2.21	1.0	1.0

*FEPA and WHO maximum acceptable limits

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ABOUT THE AUTHORS

Folawewo, Abayomi David is an Assistant Lecturer at Crawford University, Igbesa, Ogun State, Nigeria. He holds a M.Sc. degree in Pharmaceutical Chemistry from the University of Lagos. He has published several articles on natural products.

Dr. Madu, Alexandra Nnamdi, is a Lecturer I in the Department of Industrial Chemistry, Crawford University, Igbesa, Nigeria.

Dr. Adekemi Omolayo Faboyede, is a Lecturer II in the department of Biological Science, Crawford University, Igbesa, Ogun State, Nigeria.

Mr. Bamidele Muyideen Olaitan, holds M.Sc. Natural Product Chemistry from the Federal University Agriculture Abeokuta.

SUGGESTED CITATION

Folawewo, A.D., A.N. Madu, A.F. Omolayo, and O.B. Muyideen. 2017. Physico-Chemical Properties of Wastewater within Agbara and Impact on Ologe Lagoon, Lagos”. 18(1):343-348.

Pacific Journal of Science and Technology