PHYSICO-CHEMICAL CHARACTERISTICS OF INDUSTRIAL EFFLUENTS IN LAGOS STATE, NIGERIA

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Abstract: The discharge of industrially polluted effluents into municipal drains in a populated and commercially vibrant state of Lagos, Nigeria stands to pose deleterious environmental threats. The aim of this study is to ascertain the inhibitive contributions of these industrial effluents even as they flow from municipal drains into the sink (River or Lagoon). Analysis such as pH, temperature, conductivity, Total Solids (TS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil/Grease and Heavy metal determination using Atomic Absorption Spectrophotometer (Spectra AA Varian 400 plus) were carried out. Five industrial effluents discharged at point sources were collected and analysed. The 1.36-4.91 pH range does not conform to the guide line stipulated by Federal Environmental Protection Agency (FEPA). Sample A and E have the highest microbial load which reflects in their high BOD_5 as well as COD values. Unprecedented 10.54 mg/L Cd concentration in effluent B is highly unacceptable by FEPA and World Health Organisation (WHO). This study anchors on the need for treatment of industrial effluent before they are discharged into the environment.
Key words: Heavy metals, effluents, municipal, environment, microbial, discharged

INTRODUCTION

In Nigeria, industrial growth is identified as a major tool for economic development (Aina 1989, Adeyeye 2002). The production of useful consumer products is the indicators of this growth. Nevertheless, waste production is also a function of every industrial process. Ironically, these industrial corporations does not consider adequately the functionality of their waste treatment plant so as to accommodate basic treatments such as sedimentation, sand filtration, oil and grease traps and precipitators for gaseous emissions (Aina 1992, Adebayo 2007). So, the indiscriminate discharge of solid, liquid and gaseous wastes into the land and municipal drains remains the only way of disposing off their waste. Sometimes, farmers dam the flow of this waste water (industrial effluents) and use for irrigation purposes due to advantageous presence of potassium, nitrogen, phosphorus and other essential elements present in them (Niroula 2003).

However, the use of dams polluted by industrial effluents from textiles, shoes, cosmetics, plastics, and other household cum industrial consumables has its negative consequence on the plants through the alteration of the physico-chemical properties of the receiving water body. The aquatic habitats are killed by the toxic chemicals with the resultant disruption of the aquatic ecosystem and its food chain. The decomposition of the organic materials by micro-organisms in the aquatic ecosystem leads to the lowering of the level of dissolved oxygen, which in turn inhibits the growth or cause the death of the aquatic habitats (Onuegbu 2008).
The biochemical oxidation of the natural and the industrial wastewater can be represented by the following equation:
Oxidizable material + bacteria + nutrient + $O_2 \rightarrow CO_2 + H_2O$ + oxidized inorganic(s) Aleksandar DVORNIC et al. (2011)

The conductivity of the receiving water is a function of the concentration of soluble ionic salt present in the wastewater. Thus, the increase in the salinity of the receiving water body is as a result of high concentration of ionic salts present in the wastewater (Morrison et al 2001). Temperature of the wastewater at the point of discharge is also an important parameter for aquatic habitat present in the receiving water. At high temperature, the rate of dissolution of atmospheric oxygen in the water is usually low and this affects the sustainability of the aquatic habitats due to reduction in the level of the dissolved oxygen. Also, alteration of the pH level of the receiving water could affect the solubility of essential elements such as Al, Fe, B, Cu, and Mn (Akan 2009).

Bioaccumulation of metals occurs in fauna and flora if the rate of uptake of heavy metals by the organisms is more than the excretion phase (FAO 1990, Adeyeye 2002). Unlike food that when assimilated into the body digest/biodegradable, heavy metals are not biodegradable so they accumulate in primary organs in the body and over time begin to fester, leading to various symptoms of diseases. According to Fatoki and Mathabatha (2001), heavy metal distribution in seawater and sediment samples were found in high concentrations when compared to regulatory standards. This development is as a result of introduction of heavy metals into the sea through runoff from residential, urban and industrial sources. Thornton (1991) and Blume (1993) have both reported that heavy metal pollution of urban soil in many cities of Western Europe such as London and Berlin are primarily caused by anthropogenic inputs.

The physico-chemical analysis of five industrial effluents in Lagos State, Nigeria was studied. The aim of this study was to check the contributions of these industrial effluents which were daily discharged into the municipal drains that eventually flow into the Lagos Lagoon, a primary source of fishing activity in the state.

MATERIALS AND METHODS

Effluent samples were collected from five (5) different industries in Ikeja and Ikorodu local government area of the state in the year 2010. Table 1 below shows the sampling sites for this research:

Table 1: Location of sampling site

Effluent Sample	Location
Effluent A	Oba-Akran (Ikeja)
Effluent B	Adeniyi jones (Ikeja)
Effluent C	Odogunyan (Ikorodu)
Effluent D	Adeniyi jones (Ikeja)
Effluent E	Acme (Ikeja)

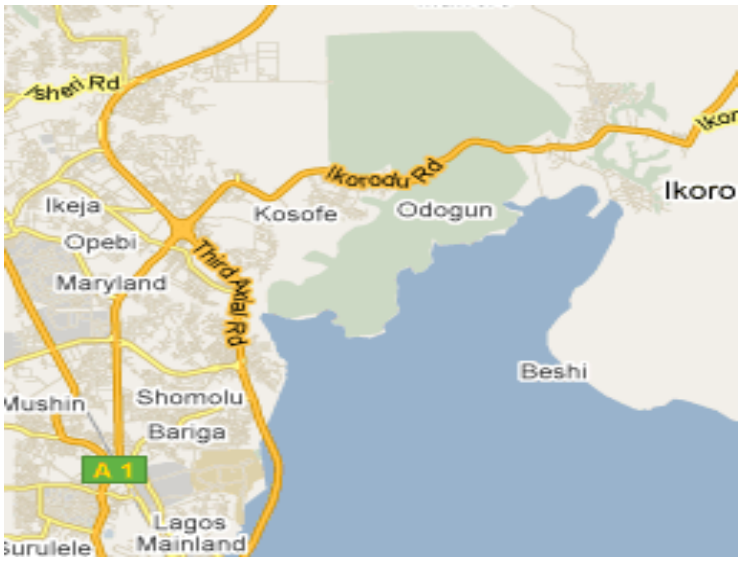

Figure 1: Map showing the sampling sites (Ikorodu, Ikeja) in Lagos, Nigeria.
Source: www.Google maps.com

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Two litre polyethene bottles were properly washed with mild detergent and then leached with 1:1 HCl overnight. At the various sampling sites, the containers were rinsed several times with deionized water before the samples were collected at the point of discharge into the municipal drain.

The pH of the wastewater samples was determined at the point of sampling using pH meter (model Jenway 3310). The pH electrode was calibrated using buffers of pH 4.0, 7.0 and 10.0. The electrode was immersed into the wastewater sample and reading was recorded. Temperature was determined using a thermometer, while conductivity was determined using a conductivity meter (Hach model C0150).

Partition gravimetric method (APHA 1992) was used for the analysis of oil and grease. In the method, oil and grease were determined by solvent extraction. The solvent was separated from water and evaporated; the residue remaining was used as a measure of the oil and grease content. The solvent mix of n-hexane and methyl tert-butyl ether (80 % and 20%) respectively was used as the extracting solvent. A 300 ml sample was acidified with 5 ml of HCl. The sample was transferred to a 1-litre separation funnel and shaken for 2 minutes. After the separation of layers, water drained off and the solvent containing oil content was transferred to a pre weighed 100 ml dish. The solvent was evaporated on a bath. After evaporation the dish was again weighed and the oil and grease content were separated.

Total solids were determined by measuring 100 ml of well mixed sample into a dry and pre-weighed evaporating dish at 103-105°C for 1 hour. The content was evaporated to dryness on a water bath; the dish was transferred to an oven and then dried to a constant weight at 105°C. The dish was allowed to cool down in a desiccator and re-weighed. This process of drying, cooling and weighing was continued until a constant weight was obtained.

BOD, COD, sulphate, oil and grease were determined using standard methods (APHA 1992). Immediately after collection of sample for metal analysis, the samples were acidified with analar

grade of 1.5 ml HNO_3 and stored in the refrigerator at 4^oC. Spectra AA Varian 400 plus Atomic Absorption Spectrometer was used in determining the concentration of the metals. The analysis was done in triplicate and the mean values were obtained.

RESULTS AND DISCUSSION

The physico-chemical parameters of the effluents investigated are presented in Table 2. The pH values of these industrial effluents range from 1.36 to 4.91. The values are not within permissible limit (FEPA 1991). The acidic nature of the industrial effluents (A, B, C, D and E) is capable of stemming the pH of their respective receiving water bodies thereby, destabilizing fundamental properties such as alkalinity, metal solubility and hardness of water. Wang et al (2002) corroborate the fact that metabolic activities of aquatic organisms are also dependent on the pH values.

Hariharan et. al. (2010) reports that bio-chemical reactions of aquatic organisms are temperature dependent. Increase in temperature of water body will promote chemical reactions in the water. Effects, such as bad odour and taste will result due to non solubility of gases such as oxygen. Effluent C, a textile cum rubber slippers producing company, had the highest mean temperature of 35.35^oC.

As the total dissolved solids (TDS) values increase the conductivity values also increase. Effluent E had the highest value of 141.25 mg/L for TDS and 349.00 µscm^{-1} for conductivity. The TDS and sulphate values for all the samples were below than the maximum permissible limit FEPA (1991).

Dissolved oxygen (DO) was not detected in Effluent A and E. These suggest that the effluent is capable of causing death of some fish and macro-invertebrates because the oxygen required by these aquatic habitats will be consumed by micro organisms (APHA 1995), The biological oxygen demand (BOD) and chemical oxygen demand (COD) are useful parameters in water quality analysis. BOD and COD are both a function of DO; decrease in DO will lead to increases in BOD and COD values. Table 1 shows that the BOD/COD ratio for effluent samples A, B, C and D are 1:1.8, 1:1.8, 1:1.6, 1:1.7 respectively. Sample E has a ratio of 1:2.8. The COD test gives a measure of the non-biodegradable organic materials present in samples A, B, C, D, and E. This test shows the advantage of the COD over the BOD analysis.

Table 2: Physico-chemical characterization of industrial effluent analysed

Effluent	pH	Temp.^oC	Cond. (µs.cm^{-1})	TS (mg/L)	TDS (mg/L)	Sulphate (mg/L)	DO (mg/)	BOD (mg/L)	COD (mg/L)	Oil/Grease
Effluent A	3.08	28.00	18.65	2.34	0.02	32.87	ND	560.00	1034.47	ND
Effluent B	1.36	31.50	32.23	0.36	0.12	28.50	2.34	340.00	642.00	ND
Effluent C	1.61	35.35	24.22	0.17	0.12	34.26	4.20	400.00	670.00	15.00
Effluent D	1.71	27.00	23.90	0.11	0.08	22.46	3.00	352.50	615.00	ND
Effluent E	4.91	30.00	349.00	310.40	141.25	2.81	ND	444.50	1254.50	ND

Table 3 shows the concentration of metals in the effluents analysed. Zn and Fe metal concentration values ranged from 1.25 to 11.93 mg/L and 0.59 to 28.73 mg/L respectively. Except for the Fe concentration of Effluent E (0.59 mg/L) all other industrial effluents considered show non compliances with the FEPA (1991) standard for Zn and Fe. Effluent B had 10.54 mg/L highest value for Cd which is also higher than FEPA (1991) recommended concentration level (< 1 mg/L). Matsuo et al. (1995) report that high concentration of Cadmium inhibits bio-uptake of Phosphorus and Potassium by the plants.

B

Effluent	Zn	Pb	Cu	Cr	Mn	Cd	Fe
Effluent A	11.93	ND	ND	0.055	ND	0.065	28.73
Effluent B	5.22	ND	ND	0.56	ND	10.54	18.87
Effluent C	1.25	ND	ND	ND	ND	ND	5.25
Effluent D	6.10	0.75	ND	ND	5.91	ND	1.00
Effluent E	3.41	ND	0.10	ND	0.39	ND	0.59

ND: Not Detected

CONCLUSION

This study has shown that industries discharge effluents with high degree of acidity, high BOD and COD values which are not in compliance with FEPA set standards. This questions the functionality of the treatment plants in these companies. Should these companies continue to discharge untreated wastes into the environment there will be building up in the metal concentrations of the water bodies and this may pose serious threat to both the aquatic habitat and human beings that consume these aquatic animals. Strict environmental laws become imperative so as to curb this stress. However, the heavy metal content profile of the effluents fell considerably within the tolerable limits stipulated by FEPA.

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