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Assessments of the Level of Contamination of Effluent from Aladja River, Delta State, Nigeria

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Abstract: ***Water quality assessment of the Aladja River, the various discharged point for the Delta Steel Company, Aladja was studied. Effluent samples collected at the various discharge point such as: Rolling mills, Electric Arc Furnace (EAF), Steel Melting Shop (SMS), Lime plant were analyzed for pH, conductivity, Biochemical Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Oil and Grease, Total Hardness, Chloride, Nitrate, Sulphate and Phosphate. In addition, metals (Nickel, Lead, Iron, Copper, Chromium, Zinc, Manganese and Cadmium) were analyzed. Results from analysis reveals the level of pH from Lime plant to be 9.60±0.15, TSS of SMS to be 111.00 ± 0.10mg/l. Data's obtained for EAF were higher than the maximum permissible limits set by Federal Environmental Protection Agencies (FEPA Nigeria). This is traced to the fact that the operations are closed circuit system. The elevated levels of some of the pollutant would invariably affect the taste, color and other physical and chemical properties of the river water and thus pose a potential health hazard of varying degrees to various life forms that depend on the water for survival and recreational purposes. A routine treatment of the effluent before discharge is therefore highly recommended to maintain good water quality. Therefore, wastewater from the Delta Steel Company Aladja, is recycled before they were discharged into the river and thus, conform to the recommended FEPA guidelines***

Keyword: Total dissolved solid, Total suspended solid, Federal Environmental Protection Agency, Steel melting shop, Electric arc furnace, Effluent, Pollution and Environment.

1. Introduction

Water is a vital resource to man. Its quantity and quality as well as its management contribute to its sustainability [1, 2]. Its usage contributes to growth and development of any nation's economy [3, 4]. Water has acquired added importance on the last few decades due to increased cost and demand, coupled with increased pollution. Pollution of the aquatic environment has been defined by UNESCO/ WHO/UNEP as the introduction by man directly or indirectly of substances or energy into the marine environment which results in such deleterious effects as harm to the living resources, hazards to human health, hindrance of marine activities including fishing and impairment of quality for use of sea water. In other words, water is polluted when its acceptable quality has been altered by man's activities through anthropogenic imputes such that its intended usage for commercial or domestic purpose is hampered [5]. It has been suggested that, waste water pollution is the leading cause of disease and death. It account for the death of more than 14,000 people daily [6, 7]. This may be attributed to the ineffectiveness of purification systems of the wastewater, and this may become seriously dangerous, leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the ecosystem [8]. [5] Reported that Water quality can be assessed using a number of lines of investigation, namely chemical, biological and bacteriological [9]. Each line has its own uses and yields information not otherwise obtainable. Chemical investigation of the water quality of some Nigerian rivers [10, 11, 12 and 13] reveals that water that was once an abundant natural resource is rapidly becoming scarce in quantity (high demand) and the quality is deteriorating in many places, owing to population increase, rapid industrialization and rural/urban migration. Almost all water used by man is returned as wastewater and requires proper disposal to prevent it from reaching and contaminating water resources. In most cases, this is not in practice due to lack of laws backing proper disposal (legislation), lack of technical knowhow and treatment plant [13]. In the river areas of Nigeria, waste such as sewage, defecation and other contaminant from the industries are directly deposited into rivers. This is the case of the Aladja River of Delta State, Nigeria. The Aladja River is open to the Delta Steel Company by virtue of location. Delta Steel Company, situated in Aladja, Warri – Delta State Nigeria, has several operations that produce huge amount of gaseous, liquid and solid waste. Effluent discharge practices in Nigeria are yet too crude and society is in danger, especially in the industrialized part of the cities. The Federal Environmental Protection Agency (FEPA) was established to check these environmental abuses. Delta Steel Company Aladja, is a federal establishment, and thus, the aim of this study is to carryout water quality assessments of the level of contamination of effluent of the Aladja River where the Delta Steel Company, Ovwian - Aladja, discharge their effluent.

2. Materials and Methods

Sample Collection

Wastewater sample were collected from over flow of the water treatment /makeup water basin. These over flows are channeled directly into the Aladja River. This was done at different discharged points of the plant such as; Rolling mills, Electric Arc Furnace (EAF), Steel Melting Shop

(SMS), Lime plant. Samples were collected in July during the peak of rainy season in plastic containers previously cleaned by washing in non-ionic detergent, rinsed with tap water and later soaked in 10%HNO_3 for 24hours and finally rinsed with deionised water prior to usage and labeled accordingly and transported to the laboratory, stored in the refrigerator at about 4^{o}C prior to analysis.

Sample Analysis

pH measurements was estimated by the means of an Orchids Tampon pH meter which was calibrated using a standard buffer solution. Conductivity /TDS meter (Hanna Instrument) was used to measure the conductivity and total dissolved solids of the water samples. In this case, the power key and the conductivity key of the conductivity/TDS meter was switch on, and the meter was also temperature adjusted; the instrument was calibrated with 0.001m KCl to give a value of 1413µs/cm at 25^{o}C/177^{o}F. The probe was dipped below the surface of the wastewater and surface water. Time was allowed for the reading to the stabilized and reading was recorded. The key was then changed to TDS key and recorded. The probe was thoroughly rinsed with distilled water after each measurement. Total suspended solid of wastewater samples were determined using standard procedures as described by [14]. Dissolved oxygen (DO) was determined by the Dissolved Oxygen Meter. The meter was calibrated prior to measurement with the manufacturer's instruction. The spectrophotometers (HACH DR 2010) for anions determination were checked for malfunctioning by passing standard solutions of all the parameters to be measured; blank samples (deionized water) were passed between every three measurements of wastewater samples to check for any eventual contamination or abnormal response of equipment [15]. The biochemical oxygen demand which depends on oxygen uptake by bacteria, was determined using the dilution method according to APHA 5210B (APHA, 1998)[16]. The amount of oxygen consumed during a fixed period (usually 5days) is related to the amount of organic matter present in the original sample. THC (Oil and Grease) was determined according to API-RP45 method using a spectrophotometer. The sample was extracted twice with 1:10 ratio of xylene to sample. The combined extract after centrifuging was read in the spectrophotometer using xylene as the reference material. The spectrophotometer had been previously calibrated with crude oil. Readings obtained from the spectrophotometer were traced out on the calibration graph and used to calculate the concentration of THC (Oil and Grease) in mg/l. Salinity as chloride was determined using the Mohr's method as described in APHA 4500-B. The titration method is based on the reaction of silver with chloride ions using potassium chromate as indicator. Silver chloride is precipitated quantitatively before red silver chromate is formed. Salinity as chloride is reported in mg/l after calculation [16]. Chemical oxygen demand (COD) was used as a measure of the oxygen equivalent of the organic matter content of the sample, which is susceptible to oxidation by a strong chemical oxidant. COD was determined using the open reflux method, where a sample is refluxed and digested in a strongly acidic solution with a known amount of excess of potassium dichromate ($K_2Cr_2O_7$). After digestion, the excess un-reacted potassium dichromate was read with a spectrophotometer at 600 - nm and results were reported in mg/l. Results were also verified by titrating with a standard solution of ferrous ammonium sulphate. The concentration of Nitrate, Sulphate and Phosphate were determined using DR/2010 HACH portable data logging spectrophotometer. The spectrophotometers were checked for malfunctioning by passing standard solutions of all the parameters to be measured., blank samples (deionized water) were passed between every three measurements of water samples to check for any eventual contamination or abnormal response of equipment. Nitrate as nitrogen was determined by the cadmium reduction metal method 8036 (DWAF, 1992)[17]. The cadmium metal in the added reagents reduced all nitrates in the samples to nitrite; while sulphate was determined by using Sulfa Ver methods 8051[17].

3. Results and Discussion

Table 1: The Physico - chemical properties of effluents from the various discharged points

Parameter	SMS	LIME PLANT	ROLLING MILL	EAF	FEPA STD
Temperature ^{o}C	28.63±0.55	29.10±0.27	28.07±0.21	28.11±0.16	< 40^{o}C
pH	7.61±0.10	9.60±0.15	6.66±0.23	7.35±0.05	6 – 9
Conductivity ms/cm	140.90±2.01	466.47±5.64	76.33±1.53	83.57±2.31	10,000
BOD, mg/l	5.60±0.16	4.79±0.17	4.75±0.07	4.54.±0.05	10
COD, mg/l	9.02±0.25	7.38±0.06	7.91±0.07	6.90±0.01	40
Dissolved Oxygen mg/l	5.90±0.05	5.59±0.04	5.86.±0.04	5.91±0.03	> 4.0
Oil &Grease, mg/l	5.08±0.21	0.51±0.15	2.16±0.16	0.16±0.04	10
Total Hardness, mg/l	33.00±1.00	137.00±1.00	12.00±1.00	29.00±1.00	200
TDS, mg/l	94.51±0.31	309.31±0.36	49.30±0.20	55.94±0.04	2000
TSS, mg/l	111.00±0.10	22.47±0.45	30.47±0.50	80.37±0.47	30

Table 2: Results of Anions at various discharged point

Parameter	SMS	LIME PLANT	ROLLING MILL	EAF	FEPA STD
Chloride, mg/l	14.67±0.35	70.69±0.27	11.42±0.39	11.60±0.51	600
Nitrate, mg/l	3.43±0.31	0.57±0.31	6.40±0.31	6.29±0.22	20
Sulphate, mg/l	12.16±0.17	9.38±0.44	7.85±0.05	6.49±0.42	500
Phosphate, mg/l	0.78±0.04	0.08±0.02	0.14±0.02	0.05±0.02	5

Table 3: Results of Heavy Metals at various discharge point

Parameter	SMS	LIME PLANT	ROLLING MILL	EAF	FEPA STD
Nickel, mg/l	ND	ND	ND	ND	<1
Lead, mg/l	ND	ND	ND	ND	<1
Iron, mg/l	1.08±0.02	0.13±0.04	0.72±0.03	2.06±0.06	<20
Copper, mg/l	0.04±0.03	0.03±0.02	0.02±0.01	0.24±0.03	<1
Chromium, mg/l	ND	ND	ND	ND	<1
Zinc, mg/l	0.06±0.03	0.06±0.01	0.18±0.03	0.25±0.04	<1
Maganese, mg/l	ND	ND	ND	ND	5
Cadmium, mg/l	ND	ND	ND	ND	<1

The quality of water depends on its physicochemical and Biological characteristics [16]. Result of the physico – chemical factors on the quality of the Aladja River revealed that the mean surface water temperature lie in the range of 28.07 ± 0.21 and 29.10 ± 0.27^{o}C. The pH values ranged between 6.66 ± 0.23 and 9.60 ± 0.15. The values fell within FEPA limit except for the pH of the lime plant which is slightly higher than FEPA specification with 9.60 ± 0.15. This could be attributed to the presence of CaO/$CaCO_3$ present in lime stone which is the basic composition of lime. Conductivity of water which was reported to be a useful indicator of its salinity or total salt content was observed to be higher in the lime plant, was found to be within the regulatory limit of FEPA. The high value recorded could be that the limestone contains high amounts of dissolved salt. The standard for sustaining aquatic life is stipulated at 5mg/l, a concentration below this value adversely affects aquatic biological life, while concentration below 2mg/l may lead to death for most fishes [18]. An important pollution index of industrial wastewaters is the oxygen function measured in terms of chemical oxygen demand (COD) and biological oxygen demand (BOD_S). COD, DO, and total hardness content are all observed to be within FEPA specification [19]. [20] Observed that the hydrocarbons are the most significant cause of toxicity in sediment samples. The concentration of Total Suspended Solid in SMS was the highest (111.00 ± 0.10mg/l). This may be as a result of the inability of the final discharge pump to recycle the effluent within the basin. Similarly, the high concentration of TSS in arc furnaces (80.37 ± 0.47mg/l) may be as a result of the storage of all process waste water from the plant in the basin for further treatment. The physico – chemical analysis at the various discharge point for the Aladja River revealed that all data obtained from the effluent were within the FEPA specification. The concentration of chloride ranges from (14.67 ± 0.35) and (70.69 ± 0.27), the highest concentration of chloride was recorded in the lime plant. Nitrate was high in rolling mills (6.40 ± 0.31mg/l) and Arc furnace (6.29 ± 0.22mg/l). These changes in concentration may be associated with the operations in the steel plant that reduces the concentration of these compounds before finally discharging the effluent. The concentration of sulphates and other anion tested for were within FEPA recommended standard. Metals such as Nickel, Lead, Iron, Copper, Chromium, Zinc, Manganese, and Cadmium were all tested for and are significantly within the FEPA recommended standard.

4. Conclusion

The discharge of industrial effluents into receiving water bodies invariably result in the presence of high concentrations of pollutant in the water and sediment if not properly treated. This study has shown that effluent from Delta Steel Company Aladja, Nigeria, generally contain low concentrations of pollutant in the water except the concentration of Total suspended solid (TSS) in SMS and EAF, pH value in lime plant which are higher than the FEPA recommended standard. The low concentration of pollutants could be traced to the fact that the operations are closed circuit system. Effluents have considerable negative effects on water quality of the receiving water bodies and as such, they are rendered not good for human use. It is therefore recommended that a more careful disposal of industrial wastes with detailed pretreatment should be encouraged.

Reference

[1] Faniran, A., (1991). Water Resources Development in Nigeria. University of Ibadan, Ibadan pp: 95
[2] UNESCO –WWAP, (2003). Water for people, water for life WHO/UNCFF (2002). The United Nation World Water Development Report (UNESCOWWAP).
[3] Katte, V. Y., Fonteh and Guemuh, G. N. (2003). Domestic water quality in urban centers in Cameroon: A case study of discharge in the West Province. African Journal of Environmental Science and Technology, 25: 45 -56.
[4] Gleitsmann, B. A., Kroma M. M. and Steenhuis, T. (2007). Analysis of a rural water supply project in three communities in Mali: Participation and Sustainability, Natural. Resource Forum, 31 :142 -150.
[5] Akaninwor, J. O. Anosike, E. O. and Egwim, O. (2007). Industrial effleunt discharge on microbial properties of new Calabar River. Scientific Research and Essay Vol. 2 (1), pp.001-005
[6] Pink, D.H. (2006). *"Investing in tomorrow's Liquid Gold"*. Yahoo http://finance.yahoo.com/columnist/article/trenddisk/3748
[7] West, L. (2006). *"World Water Day*: A Billion People Worldwide lack safe Drinking Water". About. http://environment about.com/od/environmental events/a/water dayga.html
[8] Bays, J.B.H, Schiff, K. and Washburn, L. (2003). Marine Environmental Research, 56, 205 -223
[9] Hodgkiss I. J. (1998). Bacteriological Monitoring of Hongkong Marine. Water quality. Environmental International Journal 14: 495-499.
[10] Adeniji H. A., and Mbagu G. I. (1983). Study and Appraisal of the water Quality of the Kontagora and Eku Rivers. Kainji Lake Research Institute Annual Report, pp. 17 – 22.

[11] Ajayi S. O., and Osibanjo O. (1981). Pollution Studies on Nigeria Rivers II, Water Quality of some Nigeria Rivers. Environmental Pollution Series B. (England, pp. 87-95). Alpha (1980)
[12] Asuquo F. E. (1999). Physico - Chemical Characteristic and Anthropogenic Pollution of the Surface Waters of Calabar River, Nigeria. Global Journal of Pure and Applied Science 30: 31 - 40.
[13] Imevbore AMA (1970). The Chemistry of River Niger in Kainji Lake Reservoir Area. Archiv fuer Hydrobiologie 67: 412-413.
[14] Alexandria, V. A. (1998). Official methods of analysis of the Association of official Analytical Chemists (A.O.A.C): 432-444
[15] HACH, (1997). *Water Analysis Handbook*, 3rd edition, HACH Company, Loveland, Colorado, USA.
[16] America Public Health Association (APHA) (1998). *Standard methods for the examination of water and wastewater*. 18th edition. Washington, DC Pp 45-60.
[17] Department of water Affairs and forestry DWAF (1992). Analyical methods manual, TR 151. Pretoria
[18] Ademoroti, C.M.A (1996a). *Environmental chemistry and Toxicology*. Ibadan: Foludex, Pp. 79-102
[19] FEPA (Federal Environmental Protection Agency). 1991 Guidelines to Standards for Environmental Pollution Control in Nigeria, FG Press Lagos Nigeria.238pp
[20] Grant, A. and Briggs, A. D. (2002). *Marine Environmental Research*, 53, 21-48.