Assessment of Some Physiochemical Parameters Concentration in Industrial Effluent Discharge (A Case Study of Orosikri Community in Bonny Island Waterways)

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DOI: 10.56201/ijccp.v10.no4.2024.pg66.76

Abstract

This study investigates the concentration of selected physiochemical parameters in industrial effluent discharge in the Orosikri community, Bonny Island waterways. Given the rapid industrialization in Nigeria, particularly in the Niger Delta region, concerns about the impact of untreated industrial effluents on water quality have grown significantly. This research focuses on analyzing the concentrations of key pollutants, including Nitrate, Barium, Lead, Chromium (VI), Iron, Copper, and Arsenic, in the effluents discharged into the waterways of the Orosikri community. The study employs standard laboratory methods to measure these pollutants and assesses their levels against regulatory standards such as those of the World Health Organization (WHO) and Nigeria's effluent discharge standards. The results reveal that while most parameters, including Nitrate, Barium, Iron, Copper, and Arsenic, fall within acceptable limits, Lead with 0.156 and 0.273 mg/l and Chromium 2.245mg/l and 2.395mg/l concentrations significantly exceed the permissible levels, posing a serious environmental and health hazard. These findings underscore the need for stricter enforcement of effluent treatment regulations to protect the water quality in Bonny Island and its surrounding communities. This research contributes to the understanding of industrial effluent management and its implications for environmental sustainability in the Niger Delta region.

Keywords: *Physiochemical, Wastewater, Water Quality, Effluents and Bonny*

1. Introduction

It is a known fact that one of the greatest threat to public health and the envIronment is improper treatment of effluent discharge from our factory. In recent years, several studies have highlighted the implications of industrial effluents on water resources in Nigeria (Ajibade et al., 2021). Water is polluted through natural processes that occur in the environment but most pollution is the result of human activities (Wang at el, 2004). Water is a vital substance for life on Earth, playing a crucial role in various natural processes and supporting the existence of all living organisms and its significance to human life varies according to how it occur and is managed. The ultimate discharge of effluents by industries and other anthropogenic activities in and around creeks and rivers constitute a major environmental challenges particularly in developing area such as the Niger Delta in Nigeria (Moslen and Daka, 2016). Water plays a crucial role in various industrial processes, contributing to the functionality and efficiency of diverse sectors. The advantages of water in industry are multifaceted and impact production, energy generation, and overall economic activities but a good percentage of the water in Orosikri community in Bonny waterways is being affect by industrial effluents. The rapid industrialization and urbanization in Nigeria have raised significant concerns about the quality and sustainability of these water resources, particularly in terms of pollution from industrial effluents (Adelegan, 2004; Eniola, Chukwu, & Olaide, 2010; Onanuga, Eludoyin, & Ofoezie, 2022). Therefore, Industries must adopt efficient water use practices and incorporate technologies for water conservation to ensure the long-term availability of this essential resource because either excessive or inadequate amounts of it can Lead to harm, pain, or destruction, but essentially, if it is managed well, it can be a tool for economic development and survival. This study seek to assess some physiochemical parameters concentration of industrial effluents discharge in Bonny Island.

While we acknowledge the numerous benefits of industries in the propose study area, responsible water management is crucial to address challenges related to water scarcity, pollution, and environmental sustainability of their area of operation in Bonny island waterways. However, In recent years, several studies have shown the implications of industrial effluents on water resources in Nigeria (Ajibade et al., 2021). These effluents, which contain various pollutants such as heavy metals, chlorides, phosphates, oil and grease, and Nitrates, pose a significant threat to the envIronment and human health if not properly managed and treated (Ekiye & Zejiao, 2010; Osibanjo, Daso, & Gbadebo, 2011).

Contaminants associated with industrial effluent can accumulate in and around living organisms, potentially disrupting food chains and affecting the health of humans and other marine life. Furthermore, if the water resources near Bonny Island are utilized for drinking water or agricultural purposes, contamination may pose risks to human health and envIronment.

2. LITERATURE REVIEW

2.1 Sources of Waste Water

2.1.1 Domestic Waste Water

This is waste water generated from daily human household activities. For example cooking, washing clothes and plates, cleaning electrical appliances, flushing toilets, taking baths, brushing, shaving etc. The amount of domestic waste water generated annually in Nigerian cities has significantly increased over the last fifty years due to population explosion and rural-urban migration. The total recommended basic water requirement per person per day is fifty liters of water (Gleick & Iwra, 1996). That means fifty liters of waste water on average is generated per person per day. With a population of about 206 million people (National Population Commission, 2020), that translates to 10.3 billion liters of water waste water generated per day. Recently, there has been an alarming and worrisome increase in organic pollutants (Nadal et al., 2004). Since many effluents are not treated properly, these products are discharged on the ground or in the water bodies and most of these discharges to water bodies accumulate in the system through food chain (Odiete, 1999).

2.1.2 Industrial Waste Water

The waste water discharge form industries are major source of pollution and affect the ecosystem (Morrison et al, 2001). The degradation of envIronment results by the adverse effect of industrial waste on living organism and agriculture (Anikwe and Nwobodo, 2006).This is waste water generated from industrial activities like manufacturing and processing. For example waste from refineries, car manufacturing and assembly plants, commercial animal husbandry and large scale farming.

This Kind of waste is particularly worrisome because of the toxic contents of their waste water (Akan JC, et al., 2008). It varies from industry to industry and also from country to country due to different environmental laws and levels of enforcement. Various devastating ecological effects and human disasters in the last 40 years have arisen majorly from industrial wastes causing environmental degradation (Abdel-Shafy and Abdel-Basir, 1991; Sridhar et al., 2000). The discharges from these industries constitute biohazard to man and other living organisms in the envIronment because they contain toxic substances detrimental to health (Adebisi et al., 2007; Adriano, 2001; Bakare et al., 2003).

2.1.3 Wastewater Standards

Manufacturing industries produce wastewater, otherwise known as effluent, as a bi-product of their activities. This effluent usually contains several pollutants, which can be removed with the help of an effluent treatment plant (ETP). The treated water is then safely discharged into natural water bodies like streams, rivers, seas and oceans. (Kolhe AS et al., 2011. Abdel-Shafy HI, et al, 1991.) Effluent from industries must meet the national effluent discharge quality standards set by the Nation's Regulatory bodies and may also need to meet additional standards set by international community. Consequently, any ETP must be designed and operated in such a way that it treats the wastewater to these standards (Morrison GO, et at., 2001). National regulations state that these quality standards must be ensured from the moment of going into trial production for industrial units. They also state that the National Environmental Standards Regulatory and Enforcement Agency (NESREA) can undertake spot checks at any time and the pollution levels must not exceed these quality standards. Furthermore, the quality standards may be enforced in a more stringent manner if considered necessary in view of the environmental conditions of a particular situation.

Waste discharge quality standards differ according to the point of disposal. So, the standards are different for inland surface water (canals, ponds, water bodies, water holes, river, tanks, springs or estuaries); public sewers (any sewer connected with fully combined processing plant including primary and secondary treatment); and irrigated land.

3. **STUDY AREA**

The study was undertaken in Orosikri community in Bonny Island waterways, River State, Nigeria. Bonny Island is surrounded by several bodies of water which has fishing and water transportation as their major occupation and is not directly bordered by land. Bonny Island is located within latitude 4.4670° N and longitude 7.1626° E. It is surround by Bonny River at the Northwest, Finima River at the Northeast, Opobo channel River at the Southwest and Atlantic Ocean at the south.

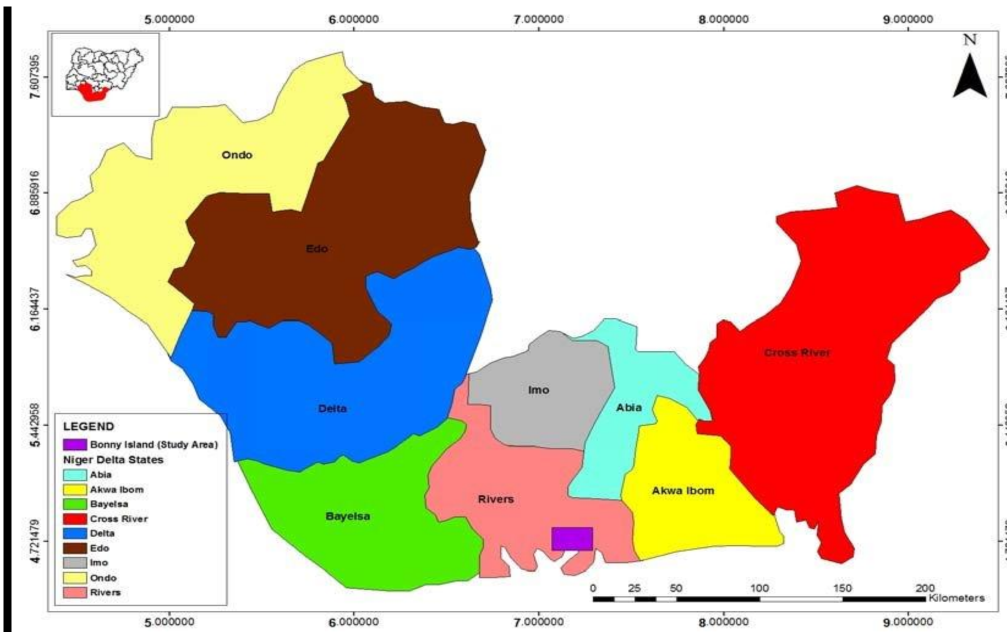

Fig 1: Map of Bonny Island

4. MATERIALS AND METHOD

In this study, Laboratory analyses were performed to assess of some physiochemical parameters concentration in industrial effluent such as Colour, pH, Nitrate (NO3), Barium (Ba), Lead (Pb), Chromium (Cr), Iron (Fe), Copper (Cu), Arsenic (As) were collected from factory plant in study location. Using clear plastics bottles, the samples were transported and their test was done the next day by using refrigerator to preserve the integrity of the sample. See methods below:

Nitrate (APHA 4500)

Brucine method was used for nitrate concentration determination in the sample. The reaction between nitrate and Brucine usually produces a yellow colour that is used for colorimetric estimation of nitrate. The intensity of the colour is proportional to the nitrate concentration and this was measured at a wavelength of 410nm using 25mm cell.

Fig 2: Hand held pH meter

Fig 3: Spectrophotometer

Heavy Metals

Heavy metals were analysed using Agilent 240ZAA Flame Atomic Absorption Spectrophotometer after acid digestion and filtration by direct aspiration into the flame through the nebulizer. 100ml of the sample was digested with aqua regia in a hot plate. The digest was filtered and made up to 100ml with distilled water. Thereafter, digest was analysed for the various metals using Agilent 240 ZAA.

Table 1: Laboratory analytical report for water samples

S/N	PARAMETER	Test Method	Ind Waste H2O 10.32	Ind. Waste H2O 10.34
1	Nitrate (mg/l)	APHA 4500 NO3-	9.84	3.86
METALS				
2	Barium (mg/l)	APHA 3111B	<0.001	0.002
3	Lead (mg/l)	APHA 3111B	0.156	0.272
4	Chromium (VI) (mg/l)	APHA 3111B	2.245	2.395
5	Iron (mg/l)	APHA 3111B	0.179	0.181
6	Copper (mg/l)	APHA 3111B	0.075	0.087
7	Arsenic (mg/l)	APHA 3111B	<0.001	<0.001

5. RESULTS ANALYSES

Colour: Color affects the entry of light into the water medium and the color of the water in the drainage as a result of the solubility of the organic substances and plankton in it.

pH: pH meter calibrated with buffers 4 and 7 was used for pH test. After calibration, the electrodes were rinsed with distilled water and gently dried using a soft tissue before being immersed into the sample for 120 seconds (2 minutes) to obtain a reading.

Nitrate (NO3): Nitrate levels in the two samples differ significantly, with 10.32 showing a higher concentration (9.84 mg/l) compared to 10.34 (3.86 mg/l). This could indicate variability in the Nitrate content depending on the time or location of sample collection.

Barium (Ba): Barium levels in the first sample (10.32) are below the detection limit (<0.001 mg/l), while in the second sample (10.34), it's detected at a very low concentration (0.002 mg/l). Both values are extremely low, indicating minimal contamination by Barium.

Lead (Pb): The concentration of Lead in the two samples is concerning. Both samples have Lead levels above the typical safe limit for drinking water (which is usually 0.015 mg/l), with sample 10.34 showing a higher concentration (0.272 mg/l) than 10.32 (0.156 mg/l).

Chromium VI (Cr): Both samples have high levels of Chromium (VI), with sample 10.34 showing a slightly higher concentration (2.395 mg/l) than 10.32 (2.245 mg/l). Chromium (VI) is highly toxic and a known carcinogen, so these levels were found to be above safe limits and could pose a significant environmental and health risk.

Iron (Fe): The Iron concentrations are very similar in both samples (0.179 mg/l and 0.181 mg/l). These values are within acceptable limits for both regulatory standards, indicating that Iron contamination is not a significant issue in this effluent.
Copper (Cu): Copper levels are slightly higher in sample 10.34 (0.087 mg/l) compared to 10.32 (0.075 mg/l). Both concentrations are relatively low and fall within safe regulatory limits.
Arsenic (As): Arsenic levels in both samples are below the detection limit (<0.001 mg/l). This indicates that Arsenic contamination is not a concern in this effluent.
Table 2: Showing the parameters evaluation across both standard

S/N	PARAMETERS	Industrial Wastewater 10.32 (mg/l)	Industrial Wastewater 10.34 (mg/l)	WHO Standard (mg/l)	Nigeria Effluent standard (mg/l)	Remark
1	Nitrate	9.84	3.86	50	20	Within limit
2	Barium (mg/l)	<0.001	0.002	0.7	nil	Below limit for WHO but can be considered safe under Nigeria's standard
3	Lead (mg/l)	0.150	0.272	0.01	0.1	Both exceed the WHO and Nigeria's Standard
4	Chromium (VI) (mg/l)	2.245	2.395	0.05	0.1	Both significantly exceed both WHO and Nigeria's standard
5	Iron (mg/l)	0.179	0.181	0.3	1.0	Within standard
6	Copper (mg/l)	0.075	0.087	2.0	1.5	Well below both standard, acceptable level

7	Arsenic (mg/l)	0.001	<0.001	0.01	0.1	Are both well below, indicating no risk from it.

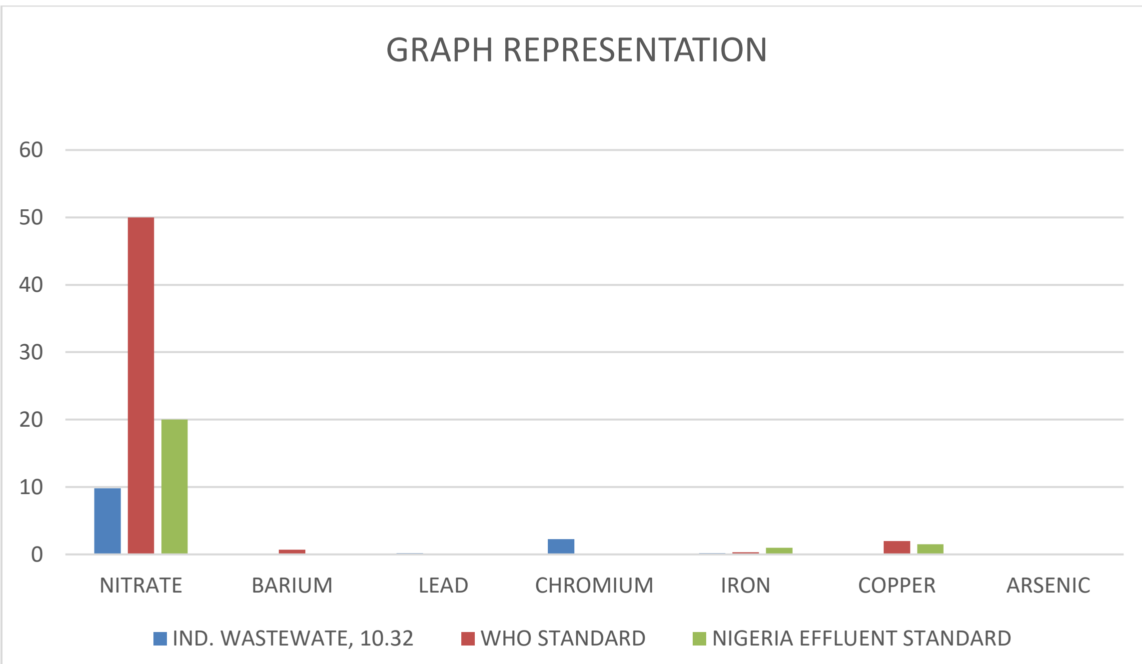

Fig 4: Industrial wastewater for 10.32 mg/l

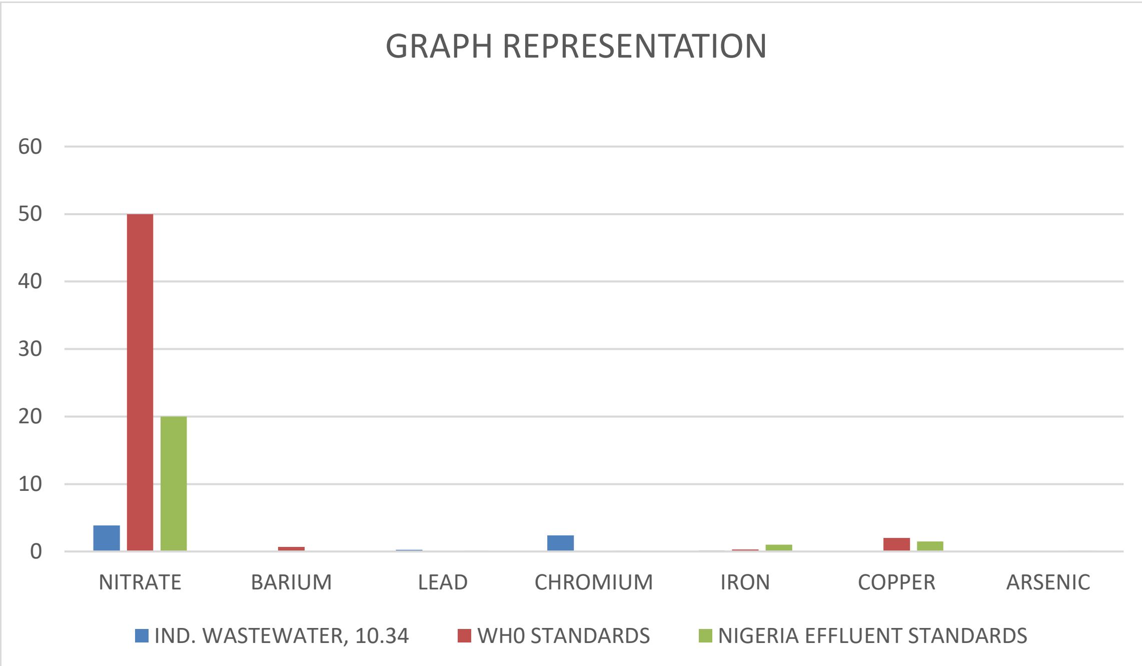

Fig 5: Industrial wastewater for 10.34 mg/l

CONCLUSION

The outcome of this study which was based on assessing some physiochemical parameters concentration in industrial effluents discharge, the following conclusions were drawn:

Most measured parameters including Nitrate, Barium, Iron, Copper, and Arsenic are within acceptable levels, although the variability in Nitrate levels between samples should be noted.

Also, Lead and Chromium are present in concentrations that may exceed safe limits, posing potential environmental and health risks.

Overall, these findings highlight the importance of continuous monitoring and improvement of effluents treatment to mitigate health risk and ensure adherence to environmental standards.

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