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# ENVIRONMENTAL IMPACT ASSESSMENT OF HEAVY METALS EFFLUIENT (CHROMIUM & NICKEL) RELEASED INTO ROMI RIVER, KADUNA STATE: A CASE STUDY

**[1]Muhammad Mudassir Usman, [1]Muhammad Nuruddeen Abdulkareem, [1]Abdullahi Muhammad & [2]Kabiru Hamza**

[1]Department of Physics, Federal University of Kashere, Gombe State
[2]Nigerian Nuclear Regulatory Authority

*Corresponding Author's Email: mudather1197@gmail.com,

**ABSTRACT**
Industrial effluents discharged into the river poses a serious threat to our environment; the research examines the impact of some heavy metals of Kaduna refinery effluent into the Romi River. It asserts the nature of effluent released into the water body and also the impact of effluent on water quality. However the important water quality became relatively slowly as early human could only judge water quality through the physical senses of sight, taste and smell, now a days there is an increase of contamination of natural water bodies by industrial effluents in developing and densely populated countries like Nigeria, because rivers are major means of waste disposal and especially effluents from industries nearby. The data used in this research were generated from direct field measurement of pH, Conductivity, and Turbidity, heavy metal profiles (Chromium & Nickel) from Kaduna Refinery Effluent. The mean concentrations of the metals; chromium, iron, nickel, and zinc with the standard deviation were found to be: $< 0.01 \pm 0.1$ mg/kg, and $0.06 \pm 0.1$ mg/kg. This study has shown that the mean concentration of chromium and Nickel found to be lower than the World Health Organization (WHO) acceptable limits while the concentration values of nickel $0.06 \pm 0.1$ mg/kg and iron $0.06 \pm 0.1$ mg/kg as found to be higher than the WHO, acceptable limits of the metals) obtained at the effluent points and this implicate the industry adjacent to the area as one of the sources of heavy metals in the river.

**Keywords:** Heavy metal, Conductivity, Turbidity, Concentrations.

## INTRODUCTION

Romi River is one of the tributaries of river in Kaduna, its located in the southern part of Kaduna metropolis between latitude 10˚ to 11˚ north longitudes 7˚ to 8˚ East, River Romi follow a course of about 16.3 km. The river is usually used for domestics and agricultural purposes. It is a major source of drinking water for both the habitant of Romi, Ridochuduku and Rido Hausawa settlement. However this settlement solely depends on the river for small scale fishing, dry season irrigation and sources of drinking water for their animals. Beside the possible danger of enriching the stream with excessive nutrient from agricultural activities that takes places along its banks, Romi stream receive effluent from Kaduna Refinery and Petrochemical Company. Among overall environmental pollution, water is one of the major threat to public health especially in developing and under developing countries as drinking water quality in these countries is poorly managed and monitored.

The petroleum refinery and petrochemical industries are most desirable for national development and improved quality of life, the unwholesome and environmentally unacceptable pollution effects of the waste from these industries are cause for worry. This is because in the process of converting crude oil into petroleum products (liquefied petroleum gas, naphtha, kerosene, diesel oil and residual oil) and petrochemical products (polypropylene, polyethylene), wastes of different kinds are generated. The wastes can be broadly categorized into oily materials, spent chemicals, spent catalyst and other residuals. These wastes are released to the environment in the form of gases, particles, and liquid effluent (liquid consisting of surface runoff water, sanitary wastewater, solid waste and sludge (Effects Of Kaduna Refinery Effluent On The Water Quality Of, 2016).

The waste water released from the refineries are characterized by the presence of large quantity of crude oil products, polycyclic and aromatic hydrocarbon, phenols, metal derivatives, surface active substances, sulfides, naphthalene acids and other chemicals (Nasser et al., 2018). As a result of ineffectiveness of purification systems, wastewater may become seriously dangerous, leading to the accumulation of toxic products in the receiving waster bodies with potentially serious consequences on the ecosystem (Nasser et al., 2018).

## MATERIAL & METHODS

Effluent (refinery wastewater) samples discharged to Romi River were collected from six (5) different points at 5m apart from the effluent passage of Kaduna Refining and Petrochemical Company (KRPC), a subsidiary of Nigerian National Petroleum Corporation (NNPC), KM 16 Kachia Road, Kaduna State, Nigeria, for three (3) consecutive weeks. The samples were kept in cleaned and dried plastic containers under laboratory condition before analysis. The reagent and apparatus used for the analysis are: Polyethylene (plastic) Bottles, 8 volumetric flasks (100 ml), glass funnel, filter paper, 8 beakers (500 ml), hot plate pipette, measuring cylinder, hydrochloric acid (HCl), nitric acid ($HNO_3$) atomic absorption spectroscopy (AAS), conductivity meter, turbidity meter and pH meter. The method employed to determine the conductivity values, turbidity values, pH values and temperature.

**Sample preparation & digestion**

According to the standard analytical method using nitric acid ($HNO_3$) and hydrochloric acid (HCl) at relatively low temperature to prevent the risk as reported by (Tinsely, (1979) and (Waliga*et al.*, (1989). A mixture of hydrochloric acid and nitric acid (10:1V/V) known as aqua regia was the potent solvent employed. 100 ml of each sample was measured and transfer into 500 ml beaker, 10 ml of hydrochloric acid (HCl) was added followed by 1 ml of nitric acid ($HNO_3$). The mixture was then heated on a hot plate at a relatively low temperature (200C – 500C) (NB: Do not allow it to boil) for about 2hours until the mixtures reduced to about 25 ml. The mixtures were then cooled and filtered using glass funnel and filter paper in a 100 ml volumetric flask, and were then diluted to volume (i.e. distilled water was added to the mark of the volumetric flask),(Imasuen & Egai, 2013). Atomic Absorption Spectroscopy (AAS) was used to run the mixtures. The six different samples we reanalyzed for the following heavy metals; Chromium (Cr), Iron (Fe), Nickel (Ni), and Zinc (Zn), based on the above procedure.

**RESULT AND DISCUSSION**

The conductivity values for the first week was analyzed at five different points are:

**Table 1: Conductivity Values**

| Samples | Conductivity Measurement (µmhos/cm) | | |
|---|---|---|---|
| **Point** | **WK1** | **WK2** | **WK3** |
| **1** | 589.13 | 522.03 | 419.61 |
| **2** | 608.72 | 496.04 | 415.04 |
| **3** | 812.42 | 487.08 | 412.12 |
| **4** | 503.21 | 501.06 | 409.18 |
| **5** | 673.24 | 513.13 | 407.23 |
| **Mean** | 637.34 | 503.87 | 412.64 |

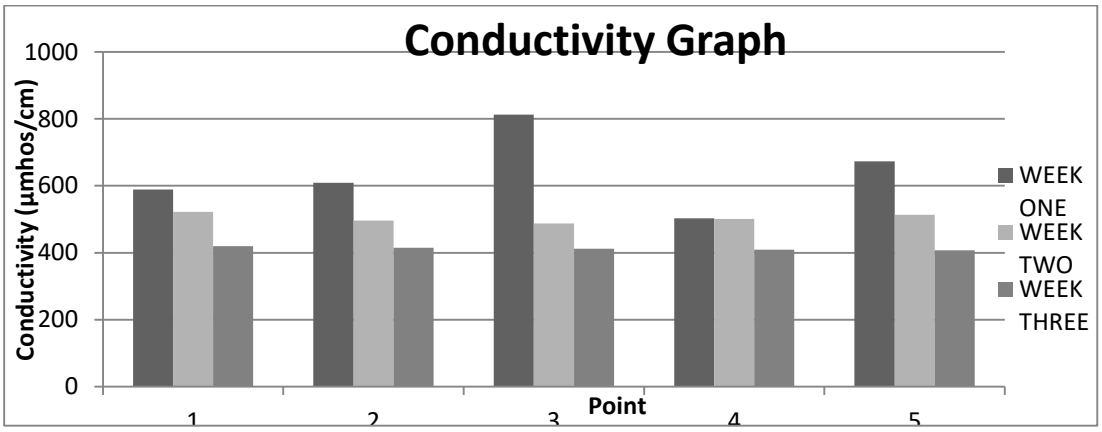


Figure 1: Conductivity Graph

The pH values for first week, second week, and third week samples at five different points are:

**Table 2: pH Values**

| Samples | pH Measurement | | |
|---|---|---|---|
| **Point** | **WK1** | **WK2** | **WK3** |
| 1 | 7.46 | 6.61 | 6.39 |
| 2 | 6.51 | 6.81 | 7.12 |
| 3 | 7.49 | 6.36 | 7.42 |
| 4 | 6.83 | 6.46 | 7.48 |
| 5 | 6.42 | 6.74 | 7.04 |
| **Mean** | 7.00 | 6.60 | 7.09 |

The temperature values recorded for the five different samples for three consecutive weeks (Week1 & Week2) at five different points in table 3.

**Table 3: pH Values**

| **Samples** | **Temperature Record (℃)** | | |
|---|---|---|---|
| **Point** | **WK1** | **WK2** | **WK3** |
| 1 | 22.30 | 20.46 | 28.61 |
| 2 | 21.80 | 20.51 | 29.33 |
| 3 | 20.87 | 20.57 | 28.84 |
| 4 | 20.68 | 20.40 | 30.63 |
| 5 | 20.63 | 20.30 | 30.10 |
| **Mean** | 21.25 | 20.48 | 29.50 |

The Turbidity values for three weeks samples at five different points are;

**Table 4: Turbidity**

| **Samples** | **Turbidity Measurement (NUT)** | | |
|---|---|---|---|
| **Point** | **WK1** | **WK2** | **WK3** |
| 1 | 27.71 | 26.53 | 46.74 |
| 2 | 18.54 | 19.63 | 43.10 |
| 3 | 34.96 | 32.58 | 35.47 |
| 4 | 44.21 | 25.39 | 40.16 |
| 5 | 41.04 | 31.38 | 37.13 |
| **Mean** | 33.30 | 27.10 | 40.52 |

**Table 5: Turbidity**

| **Samples** | **The concentration of Chromium (mg/kg) in the samples** | | |
|---|---|---|---|
| **Point** | **WK1** | **WK2** | **WK3** |
| 1 | < 0.0100 | < 0.0100 | < 0.0100 |
| 2 | < 0.0100 | < 0.0100 | < 0.0100 |
| 3 | < 0.0100 | < 0.0100 | < 0.0100 |
| 4 | < 0.0100 | < 0.0100 | < 0.0100 |
| 5 | < 0.0100 | < 0.0100 | < 0.0100 |
| **Mean** | | | |

**Table 6: Turbidity**

| **Samples** | **The concentration of Nickel (mg/kg) in the samples** | | |
|---|---|---|---|
| **Point** | **WK1** | **WK2** | **WK3** |
| 1 | 0.9136 | < 0.0100 | < 0.0100 |
| 2 | 0.0690 | < 0.0100 | < 0.0100 |
| 3 | 0.0634 | < 0.0100 | < 0.0100 |
| 4 | 0.0142 | < 0.0100 | < 0.0100 |
| 5 | < 0.0100 | < 0.0100 | < 0.0100 |
| **Mean** | | | |

The result showed that the conductivity values were generally more than the WHO maximum permissible limit of 500 µmhos/cm, this is an evident from the mean of 637.34µmhos/cm recorded. The highest conductivity of 812.42µmhos/cm as recorded in point 3, 637.24µmhos/cm in point 5, 608.72µmhos/cm in point 2, and 589.13µmhos/cm in point 1, while that recorded at point 4, 503.21µmhos/cm was just a little above the WHO standard limit compared to those at the other points.

The conductivity (µmhos/cm) values for the second Week was analyzed at five different points are; 522.0313 µmhos/cm, 4896.0413 µmhos/cm, 487.0813 µmhos/cm, 501.0613 µmhos/cm and 513.13 µmhos/cm, this showed that the conductivity values were generally more than the maximum value of 500 µmhos/cm limits of WHO standards. This is an evident from the mean of 503.87 µmhos/cm recorded. The highest conductivity of 522.03 µmhos/cm was recorded in point 1, 501.06 µmhos/cm in point 4 and 513.13 µmhos/cm in point 5, while that recorded at point 2, and point 3 were

all within the WHO standard limit.

The conductivity (µmhos/cm) values for the third week was analyzed at five different points are; 419.61 µmhos/cm, 415.04 µmhos/cm, 412.12 µmhos/cm, 409.18 µmhos/cm & 407.23 µmhos/cm this showed that the conductivity were less than the maximum value of 500 µmhos/cm limits of WHO standards. This is an evident from the mean of 412.64 µmhos/cm recorded. The highest conductivity of 419.61 µmhos/cm was recorded in point 1, 415.04 µmhos/cm in point 3, and the lowest were recorded at point 5, point 5, and point 1 were all lower than the WHO standard limit.

The pH values are generally within the WHO acceptable limits of 6.50 – 9.20 thresholds. This is evident from 6.89 mean pH value that was within the 9.20 WHO thresholds. However, if pH values fall outside the WHO acceptable limits could be attributed to the effluents that enter the river from the Kaduna Refining and petrochemical company. The low pH values increase concentrations of some dissolved metals in the water and increase the toxicity of these metals.

The temperature values recorded are generally less than the room temperature of 25 $^{O}$ C while those of third week were greater than the room temperature. This is an evident from the mean temperature values of 21.25 $^{O}$ C, 20.48 $^{O}$ C and 29.50 $^{O}$ C. However, if the temperature values are less than or greater than the room temperature acceptable limits, could be as a result of the effluents that was being discharged to the river from the Kaduna Refining and petrochemical company.

The turbidity measures are more than the maximum limits of WHO and Federal Environmental Protection Agency (FEPA) standard acceptable standards of 25.00 NTU, which ranges between 14.01 NTU – 25NTU. This is an evident from the mean turbidity value of each and every week presented above, however the level of turbidity in this area thereby making the water not suitable for consumptions.

The level of Chromium (Cr) in the five (5) different samples at different points for Week 1, Week 2, and Week 3 samples respectively were less than 0.0100mg/kg (<0.0100mg/kg). This is evidence from the mean (<0.0100), standard deviation (0.0112), and variance (0.0001) which shows to what extent individual metal is scattered about their arithmetic mean. The coefficient of correlation among the three (3) weeks was found to be zero (0), which means that there was no correlation among them. WHO and FEPA standard for drinking water was 0.05 – 2.0mg/kg.

The level of Nickel (Ni) in the five (5) different samples at five different points, for week1 samples, at points 1, 2, 3, and 4, the amount decreases while at point 5, there was a drastic decrease in the amount.

For week2 and week3 samples, the amounts at the all points (i.e. points 1-5) were less than 0.0100mg/kg. This is evidence from the mean of the three weeks: 1.0502, < 0.0100 and < 00100 standard deviation: 0.5094, 0.0112 and 0.0112, and variance: 0.2595, 0.0001 and 0.0001. The coefficient of correlation among the three (3) weeks was found to be zero (0) which means that there was no correlation among them, the recommended value of nickel for drinking water by WHO was 0.02 mg/L.

## CONCLUSION

In consideration of effluents pollution, the turbidity and Concentration of heavy metal thereby making the water in these areas not suitable for consumption and some of the heavy metals concentration such as iron and nickel are of much priority particularly in the Kaduna refinery effluent (Wastewater) discharged to Romi River at Kaduna Refining and Petrochemical Company (KRPC). The presence of these heavy metals in Romi River increases the likelihood of people in this area and its environs developing cancer, neurological disorders and the impairment of vital organs which could increase death rate and reduce productivity.

There should be a law, which should be enforce to ensure the effluent are properly treated, tested and confirmed to be fit before discharged into the river

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