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Physicochemical Analysis of Raw Water From Romi River (A Tributary of Kaduna River), Kaduna State. Nigeria

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Abstract : *The study investigated the physicochemical parameters of River Romi, Kaduna State (10°18' to 10°30' N and 7°15' to 7°45' E). The aim of the study is to assess the effect of KRPC effluent on water quality of the river. The samples were obtained, before the point of discharge (Sample A), at the point of discharge (Sample B) and after the point of discharge (Sample C). Physicochemical parameters were analyzed and the results were compared with the permissible limit allowed by National Environmental Standards and Regulations Enforcement Agency (NESREA) and World Health Organization (WHO). The result reveals that pH value is within standard for the sample at discharge point but slightly below standard for the samples at upstream and downstream. The BOD, Turbidity, COD, and Phosphates at all the three sampling points are above NESREA and WHO standards. The TSS is within standard at the point of discharge and at above standard at upstream and downstream. The DO, Nitrate, Nitrite, Sulphate, Sulphide, TDS, Conductivity and Temperature values are within the permissible limits at all points. The results of the analyses for the samples collected from the three sample points suggest that River Romi might have been contaminated by the effluents discharged from KRPC. The solution proffered includes rehabilitation and cleaning of effluent water retention pond so that effluents water should be treated before discharge. Kaduna State Environmental Protection Authority (KEPA) and NESREA should ensure compliance with national standard for water quality guidelines.*

Keywords : *KEPA, KRPC, NESREA, Physicochemical, Romi River, WHO*

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I. Introduction

Water is a natural resource of fundamental importance, supports all forms of life and creates jobs and wealth, tourism, recreation and fisheries [1]. Without water life as it exists on our planet is impossible [2]. Water is an important geomorphic agent playing a significant role in weathering the most important energy regulator in the heat budget of the earth [3]. Freshwater therefore, is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. The demand for fresh water has increased with the ever-increasing population in the world. About half of the people that live in developing countries do not have access to safe drinking water and 73% have no sanitation and some of their wastes eventually contaminate their drinking water supply leading to a high level of suffering [4]. Every human use water, whether for drinking, irrigation, and industrial processes or for recreation has some quality requirements in order to make it acceptable. This quality criterion can be described in terms of physical, chemical and biological properties of such water [5]. Polluted water consists of Industrial discharged effluents, sewage water, rain water, agriculture or households cause damage to human health or the environment. This water pollution affects the health and quality of soils and vegetation. Some water pollution effects are recognized immediately, whereas others don't show up for months or years [6]. Although industrialization is inevitable, various devastating ecological and human disasters which have continuously occurred over the years implicate industries as major contributor to environmental degradation and pollution processes of various magnitudes. Industrial waste and emissions contain toxic and hazardous substance most of which can be detrimental to human health, consequently, raw water from polluted rivers and streams form the major source. A study on water quality of Ogun River (Nigeria), in which industrial effluent from Lagos and Abeokuta is discharged, was conducted, and it was reported that the level of turbidity, oil and grease, fecal coli form and iron were very high in all the sampling sites.[7]. The focus of this study is to assess the effects of industrial effluents discharge on the water quality of Romi River in Chikun Local Government Area of Kaduna state. Kaduna Refinery and Petrochemical Company of Kaduna also known as Kaduna Refinery is the major factory that drains its wastes into the Romi River. The petroleum refining industry is primarily engaged in the manufacturing of fuel, lubricants and petrochemical intermediates, using petroleum as a principal input material [8].

II. Material And Methods

The study covers some part River Romi, which is a tributary of Kaduna River which drains the southern part of Kaduna metropolis. It is located between Latitudes $10^{o}18'$ to $10^{o}30'$ N and Longitudes $7^{o}15'$ to $7^{o}45'$ E. Romi River follows a course of about 16.4km and the area is situated on a relatively low plain liable to flooding. Collection of water samples was done in the morning between 8am and 9am. Samples were collected using Grab method, according to [9]; Samples were collected into clean plastic bottles and were taken to the laboratory within twenty-four hours for analysis. Water samples were collected by lowering pre-cleaned plastic bottles into the bottom of the water body and allowed to over flow before withdrawing. Three sampling points were used, Which a total of 3 samples were collected and used for the analyses. The first sampling point was the up stream, is located before the discharge of waste water treatment plant of KRPC enters the river. The water here is clear and running fast. There is no visible disturbance or siltation to this location. the second sampling point was at the refinery waste water discharge point, before the refinery effluents water enters the river and the third sampling point was at the point just immediately after the refinery effluent mixed with the river water. The study was carried out during dry season. The physico-chemical parameters were determined according to procedures outlined in the Standard Method for the Examination of Water and Waste water [10]. As indicated in the sampling, the parameters analyzed are those believed to have effects on water quality [11]. These parameters are pH, Temperature, Electrical conductivity, Turbidity, Dissolve Oxygen (DO), Biochemical Oxygen Demand, (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), Dissolved Solids (DS), Total Solids (TS), Chloride Test, Sulfate Test, Sulfide Test, Nitrate Test, Nitrite test and Phosphate test. The basic techniques used were: Gravimetric, Titrimetric and Volumetric techniques. The gravimetric technique was used to analyze TS, DS and SS, The titrimetric techniques was used to determine the concentration of chloride, while the volumetric technique was used to determine the concentration of DO, BOD and COD.

III. Results And Discussion

The result of all the analyses conducted in this research work is tabulated in Table 1 below. Sample A represents the sampled water at 5 km upstream, sample C represents 5km downstream and sample B represents the discharge point of refinery effluent The implications of the results were discussed as the results are presented.

TABLE 1: Values of Physico-chemical Parameters Measured across Sampling points

PARAMETERS	SAMPLE A	SAMPLE B	SAMPLE C	NESREA	WHO
pH	6.31	6.56	6.45	6.5 – 8.5	6.5 – 8.5
Temperature (^{o}C)	27.9	27.9	27.9	30	30
Conductivity µs	95.6	148.8	143.3	240	250
Turbidity (NTU)	19.1	78.0	72.7	5	5
Dissolve oxygen (mg/l)	1.61	1.54	1.61	10	10
Biological Oxygen Demand (mg/l)	10.43	11.92	29.8	10	10
Chemical Oxygen Demand (mg\l)	54.94	146.49	183.12	40	40
Chloride (mg/l)	10.34	6.89	6.89	250	250
Sulfate (mg/l)	< 0.01	58.1	< 0.01	100	100
Sulfide (mg/l)	< 0.01	0.02	< 0.01	0.05	0.05
Nitrate (mg/l)	0.51	0.39	0.84	45	50
Nitrite (mg/l)	< 0.01	< 0.01	< 0.01	0.2	0.2
Phosphate (mg/l)	1.7	3.5	1.3	0.1	0.1
Total Dissolve solid (mg/l)	127.4	105.4	202.5	200	250
Total Suspended solid (mg/l)	93.5	20.4	97.2	30	30

The parameters analyzed in table 1 are good indicators of pollutants that affect surface water quality to a large extent. Among the physical parameters measured was the pH which was found to be 6.31 upstream which is acidic in nature, 6.56 at the effluent discharge points which is acidic and 6.45 downstream which is also slightly acidic, upstream and downstream pH values fell short of the standard while at the effluent discharge point is within WHO/NESREA. Regarding the total suspended solid (TSS), the results obtained do not conform to the permissible limits of 30mg/l as stipulated by NESREA 2007 and WHO 2006. There is a rise from 93.5mg/l upstream to 97.2mg/l downstream and a sharp increase to 20.4mg/l at effluent discharge point. The high TSS content could have originated from the organic solids. The temperature of the water sample which was found to be 27.9^{o}C upstream, 27.9^{o}C at effluent discharge point and 27.9 downstream. Therefore the temperature did not exceed the NESREA 2007 and WHO 2006 standard limits of 30^{o}C. This result varies with the findings of Lekwot et al (2012) who reported that temperature is 35^{o}C upstream, 38^{o}C at discharge point

and 36 ^{o}C downstream of Romi River. The analysis conducted on Electrical Conductivity (EC) of the water sample indicates that the EC value was 95.6µs upstream and 143.3µs downstream with a sharp increase of 148.8µs at effluent discharge point. This indicates that EC is high at effluent discharge point and has exceeded the NESREA 2007 and WHO 2006 maximum limits of 250µs, when this result is compared with the values reported in [12] in their findings reported that EC 250µs upstream, downstream 240µs and 300µs discharge point. Regarding the total suspended solid (TSS), the results obtained do not conform to the permissible limits of 30mg/l as stipulated by NESREA 2007 and WHO 2006. There is a rise from 93.5mg/l upstream to 97.2mg/l downstream and a sharp increase to 20.4mg/l at effluent discharge point. The high TSS content could have originated from the organic solids. [13] observed that small suspended solids particles make water turbid while previous research by [12] shows that TSS remain high at all sample points in river Romi as against the permissible limits of 30mg/l, with upstream value of 40mg/l, discharge point 100mg/l and downstream 70mg/l value recorded. The result for total dissolved solid was observed to be high at 127.4mg/l at upstream, 202.5mg/l downstream and 105.4mg/l at effluent discharge point. The results show lower values compared to 200mg/l NESREA 2007 and WHO 2006 standard of 250mg/l. however the concentration of TDS as compared to previous study by [12] reported that TDS is quite high with upstream 300mg/l, discharge point 400mg/l and downstream 250mg/l. The turbidity results of the water sample analysis upstream is 19.1NTU, 72.7NTU downstream, and 78.0NTU effluent discharge point .It is higher than the permissible limit of 5NTU this could be attributed to high concentration of effluents. All values are above the WHO/ NESREA standard. It was observed that the color of the water sampled at river Romi is light brown in appearance. This indicates the floating of waste oil from the refinery and dissolved dust particles from farmlands around the river Romi. It was also observed that the water in River Romi has a sharp chocking smell especially downstream. At effluent discharge point, the water appearance is shining brownish colour, it is not available for WHO/NESREA standard. This indicates the presence of floating waste oil and oil chemicals. The result for the biological oxygen demand (BOD) upstream is 10.43mg/l, downstream 29.80mg/l and 11.92mg/l at effluent discharge point. This is in conformity with the permissible standard of 10mg/l of the NESREA 2007 and WHO 2006. [14], stated that the presence of organic parameters in the surface water serves as measures for pollution dictation. [12] recorded 2500-3000mg/l in Romi River which is ten times the strength of domestic water. The chemical oxygen demand (COD) measured upstream is 54.94mg/l, downstream 183.12mg/l and 146.49mg/l at the effluent discharge point. The COD values as measured at these points are all higher than the permissible standard of 40mg/l of the NESREA 2007 and WHO 2006. Especially at the downstream point, the COD value is three times the permissible standard. This indicates a high presence of organic pollutant and is higher than what is obtained by [12] COD do not conform to the permissible limits for inland waters but less than what is obtained in this study. In terms of dissolved oxygen (DO), upstream is 1.61mg/l, 1.61mg/l downstream and 1.54mg/l at effluent discharge point. It was observed that the values for DO appear to be lower than stipulated 10mg/l of NESREA 2007 and WHO 2006 permissible standard while according to [12] DO content of water samples indicates that it is almost normal upstream 9.8mg/l at discharge point it decreases drastically to 2.0mg/l and increases as it moves downstream with 9.0mg/l. The reason for this low values could be as a result of activation, since the water at the effluent discharge point is being pumped with high pressure supplied by an air compressor. Nitrate (NO_3) create oxygen deficit, also determine water purity and is a pointer to water pollution in surface water [15]. The results shows that nitrate concentration is (NO_3) 0.51mg/l upstream, 0.84mg/l downstream and 0.39mg/l at effluent discharge point, these values are low and increase both at upstream and downstream of river Romi and after the effluent discharge point. When compared with previous study by [15], it was observed that the nitrate was very low at both dry and rainy season upstream with 0.7mg/l and 0.9mg/l, at discharge point 0.3mg/l and 0.4mg/l while downstream 0.8mg/l and 0.9mg/l which is lower than WHO 2006/NESREA 2007 permissible limits. The parameters when compared with NESREA and WHO some of the results are above the maximum permissible standard which may cause environmental degradation, pollution and reduce the effect of solar energy absorption while others are below the permissible standard which may not affect human and aquatic life.

IV. Conclusion

The study analyzed water samples from River Romi, It was observed that River Romi has been contaminated by the effluents discharged from the refinery. The results show that despite the 5km distance which would have enhanced rapid purification many of the parameters measured were high above the permissible limits set by NESREA and WHO for instance turbidity with value 19.1NTU upstream, 78.0NTU at discharge point and 72.7 NTU downstream instead of 5 NTU by both NESREA and WHO, also COD with value 54.94mg/l upstream, 146.49mg/l at discharge point and 183.12mg/l downstream instead of 40mg/l by both NESREA and WHO. Suspended solid with value 93.5 mg/l upstream, 20.4 mg/l at discharge point and 97.2mg/l downstream instead of 30 mg/l by NESREA and WHO. The result indicated that all samples collected at the

collection points upstream, downstream and at discharge point varies in pollutants concentration, especially with the downstream of the river being more polluted than the upstream. Also the effluent discharge point show high levels of pollutants for some physico-chemical parameters. Moreover the results from this study shows that the River Romi in Kaduna State is already polluted in the stretch studied. Therefore, the relevant government authority should establish a waste treatment facility that will reduce the amount of stench being experienced, domestic and chemical pollutants being discharged into the river, like the COD and total solid pollutions and improve the portability of the water according to WHO (2006) standards.

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