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Some Physicochemical Parameters of Wastewater from an Oil Industry at Point of Discharge in Port Harcourt, Rivers State, Nigeria

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ABSTRACT

Wastewater samples were collected from an oil industry at the point of discharge for a period of two years, from January 2018 – December 2019. The wastewater samples were analyzed for different physicochemical parameters such as temperature, turbidity, total dissolved solids (TDS), total suspended solids (TSS), conductivity, pH, alkalinity, salinity, total hydrocarbon content (THC), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) to examine their conformity to fulfill requirements as recommended by World Health Organization (WHO), Federal Ministry of Environment (FME) and Drinking Water Association (DWA). The results indicated that all the parameters in the discharged wastewater were within acceptable limits of the regulatory bodies. The field data showed that the investigated firm conformed to the law by carrying out proper procedures before discharging the effluents into the public drain and river. Therefore, the release of wastewater from the industry doesn't constitute a danger to the environment as well as aquatic organisms.

Keywords: Physicochemical parameter, wastewater discharge, oil industry, environment, contaminants

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INTRODUCTION

The rise in population has detrimental impacts on aquatic environments. This is as a result of industrial input sources which directly discharge different types of chemicals through effluents or wastewater to aquatic systems (Chauhan, 2014). It is a fact that these chemical constituents discharged into the environment have negative environmental effects on aquatic biota and humans (Dhingra et al., 2015).

One of the ways through which pollutants or contaminants are introduced by industries into the aquatic environment or water bodies is by wastewater discharge (Singh et al., 2012). These pollutants contribute to the level of oxygen available in the water and also the nutrient content potentials of the water bodies, thus promoting a poisonous environment and leading to an unstable aquatic ecosystem (Morrison et al, 2001).

Ever-increasing quantity of wastes from industries and private homes is practically discharged into surface waters. In some or most cases, the treatment provided by the effluent discharging industry may be inadequate may not be inadequate to provide the required level of protection that the receiving water body or environment requires (Edori and Nna, 2018). With the limited capacity of institutions or weak institutional framework as a result of nonchalant attitude and or poor funding of established government institutions within metropolitan city, the pursuit for actualizing normal standard of waste discharge (effluents, produce water or wastewater) is not practically enforced to the maximum (Joel et al., 2009; Wokoma and Edori, 2017).

In several urban settlements, the management and treatment of the public sewage system and industrial wastewater is poor. Even where there exists some form of treatment, there is the possibility of improper monitoring. On the other hand, the facilities provided for monitoring the wastewater discharging industry are not renewed, inadequate, redundant, or outdated and so

Table 1: Physical Parameters of Wastewater at Point of Discharge in 2018.

Months	Physical Parameters				
	Temperature (°C)	Turbidity (NTU)	TDS (mg/L)	TSS (mg/L)	Conductivity (µS/cm)
January	32.00±1.00	3.00±0.11	60.00±7.00	2.57±0.46	113.88±15.12
February	28.76±0.93	5.8±2.82	117±25.00	20.81±15.31	223.50±44.50
March	30.50±0.50	3.71±0.69	55.86±14.14	4.375±0.76	115.84±17.17
April	29.56± 1.32	8.25± 0.35	57.00±8.05	2.77±0.43	111.30±15.70
May	28.25±0.25	2.69±0.09	66.86±2.86	4.53±0.80	104.00±15.00
June	26.50±0.50	3.07±0.64	66.30±4.30	4.22±1.08	128.20±5.20
July	26.55±0.05	7.135±4.78	200.66±129.34	6.92±5.81	389.00±263.00
August	26.25±0.03	4.71±1.02	81.00 ±1.00	6.42±4.41	154.35±1.35
September	28.50±0.05	8.65±4.99	62.36±2.64	3.45±1.08	110.98±0.98
October	28.75±0.25	3.44±0.07	62.00±19.00	3.94±0.90	112.50±22.51
November	29.75±0.25	3.35±0.37	63.67±12.34	4.47±0.36	104.36±21.64
December	27.59±0.38	10.12±4.26	24.35±5.35	4.89±1.45	63.71±27.71
Mean±SD	28.58±1.65	3.33±2.48	76.42±42.47	5.78±4.69	214.365±30.30

cannot be effectively utilized for the intended purpose (Fatta-Kassinos et al., 2011).

With these prevailing situations at hand, the sources of wastewater (the industries), freely discharge untreated effluent to surface water or the sewer system without fear, this results in a very high level or degree of contamination or pollution of river systems (Edori et al., 2019).

With the attendant situation in the megacity of Port Harcourt, Rivers State, Nigeria, where numerous multinational and local industries operate, coupled with associated wastewater discharges from them, this study was carried out to examine some physicochemical parameters in wastewater discharged from an oil industry at the discharge point.

MATERIALS AND METHODS

Wastewater samples were collected from the final point where it empties into the stream using a 1 litre container. The containers were initially washed with distilled water and rinsed with HCl. Further rinsing of the container was done with de-chlorinated tap water to remove traces of acid that might remain in the container. The samples were sealed immediately after the collection of the wastewater. Sampling was done thrice in a month for two years (January 2018 - December 2019).

The water samples were analyzed for physicochemical parameters as follows: Turbidity, total dissolved solids (TDS), electrical conductivity, water hardness, salinity, hydrogen potential (pH) were analyzed in-situ with a U-52 Horriba water checker. The temperature was examined with a handheld thermometer. The total hydrocarbon content of the water was examined using a HACH spectrophotometer after being extracted with toluene.

The filtration method was used to determine total suspended solids (TSS). A filter paper was weighed before filtration and then dried to constant weight thereafter, the paper was reweighed and the difference between the two weights recorded as the TSS value. Biochemical oxygen demand (BOD) was examined with DO instrument after being kept in the dark for five days. The analysis of COD was done Titrimetrically.

RESULTS AND DISCUSSION

The result of the physical parameters from the wastewater discharged by the oil industry in each month between 2018 and 2019 are shown in Tables 1 and 2. The values of temperature varied from 26.25±0.03 - 32.00±1.00 °C with an average mean value of 28.58±1.65 °C in 2018, whereas the values observed in 2019 varied from 27.75±0.25 - 29.25±0.25 °C, with a mean value of 28.75±0.56 °C. The highest temperature of discharged effluents within the period of investigation was observed in January 2018, while the lowest observed value was observed in August 2018. All the values observed for temperature were lower than the permitted limit of 40 °C for industries (FEPA, 1996; Iwuozor and Emuobosa, 2018).

The values of turbidity observed within the experimental period showed that in 2018, the range was between 3.00±0.11 - 10.12±4.26 NTU, with an observed mean value of 5.33±2.48 NTU, while the values of 2019 varied from 2.93±0.39 - 16.71±7.29 NTU and a mean value of 7.43±4.33 NTU. The lowest and highest values of turbidity in the discharged effluents were observed in 2019 in May and October respectively. The turbidity values in the discharged effluents were either lower or higher than the WHO/NAFDAC value of 5 NTU for drinking water. The turbidity values of the present work were very low when compared with the values observed in wastewater from Sudanese fermentation industry, where values ranged from 600 – 6800 NTU (Abdel *et al*., 2013) and also lower than the values observed in the brewery industry in Imo State, where turbidity values were high to the level of 847 NTU (Iwuozor and

Table 2: Physical Parameters of Wastewater at Point of Discharge in 2019.

	Physical Parameters				
Months	**Temperature °C**	**Turbidity (NTU)**	**TDS (mg/L)**	**TSS (mg/L)**	**Conductivity µS/cm**
January	27.75±0.25	6.25±2.86	29.695±8.70	3.975±1.75	57.35±14.35
February	29.25±0.25	5.95±2.17	29.55±2.55	1.995±0.24	54.36±3.36
March	29.25±0.25	5.82±2.13	224.00±140.00	4.08±1.84	390.00±218.00
April	29.25±0.25	3.15±0.23	52.23±19.78	1.43±0.79	97.86±32.14
May	28.75±0.25	2.93±0.39	44.00±18.00	2.64±0.37	84.50±33.50
June	29.25±0.25	8.83±2.89	60.15±20.85	11.42±2.01	123.50±41.5
July	28.50±0.50	4.24±0.13	85.57±3.44	4.96±0.15	154.50±8.50
August	28.00±0.00	12.14±0.67	17.08±1.39	3.79±1.93	30.78±1.09
September	28.50±0.50	14.03±0.34	4.36±0.46	36.36±0.25	66.57±1.83
October	28.00±0.00	16.71±7.29	45.86±2.86	8.07±4.04	44.10±37.90
November	29.25±0.25	4.16±0.22	40.80±2.80	4.38±0.44	65.00±4.00
December	29.25±0.25	4.97±1.35	160.50±64.5	2.78±0.55	300.00±130.00
Mean±SD	28.75±0.56	7.43±4.33	66.15±61.15	7.16±9.19	122.38±106.47

Emuobosa, 2018).

The clearness of water is a measure of the level of turbidity and is dependent on the amount of suspended particulate matter present in the water. High turbidity increases the opaqueness of the water. Highly turbid water absorbs heat from the sun and thus increases the temperature of the water. This, therefore, cause a reduction in the amount of oxygen that the water can retain and also interfere with the light quality of the water environment and so inhibit the photosynthetic capacity of aquatic plants and other light-dependent activities of water-dwelling organisms such as feeding and mobility (Edori and Nna, 2018). The turbidity of wastewater samples is subject to the strength of wastewater. When the waste is present in high concentrations, the turbidity is increased (Abdel *et al.,* 2013).

The value of Total dissolved solids (TDS) in the wastewater within the investigation period in 2018 was observed to be in the range of 24.35±5.35 - 200.66±129.34 mg/L, with a mean of 76.42±42.47 mg/L, while in 2019, the range was observed between 4.36±0.46-224.00±140.00 mg/L, with a mean value of 66.15±61.15 mg/L within the year. The lowest and the highest values of TDS in the effluents were observed in 2019 in the months of September and March respectively. The values observed for TDS within the period of investigation in the wastewater were lower than the WHO (2006) and FME (2011) discharge wastewater requirements of 1500 and 2000 mg/L. respectively. The values of TDS observed in the present study is lower than the values observed in brewery wastewater (Iwuozor and Emuobosa, 2018), in used water effluent from a dye and bleach producing company (Gupta *et al*., 2017), but within the same values observed in sewage waste water from a sewage treatment plant (Agoro *et al*., 2018).

TDS is used to measure the amount of both organic and inorganic constituents present in water. The analytical importance of TDS is its capacity as a tool to assess the aesthetic condition of water for consumption (Iwuozor and Emuobosa, 2018). Thus, it constitutes a broad consideration of different chemical species which may be ionic or neutral that is dissolved in the water.

The observed concentrations of total suspended solids (TSS) in the wastewater effluents in 2018 varied from 2.57±0.46 - 20.81±15.31 mg/L, with a mean value of 5.78±4.69 mg/L. the values observed in 2019 ranged from 1.43±0.79 - 36.36±0.25 mg/L, with a mean value of 7.16±9.19 mg/L. The values of TSS in the discharged effluents were lowest in April 2019 and highest in September 2019. The values of TSS observed in the discharged wastewater from the present work is higher than the FME (2011) recommended value of 0.75 mg/L for wastewater to be discharged, but lower than the values of DWA (1999) and WHO (2006) discharge values of 25 mg/L and 60 mg/L respectively. The observed values of TSS in this work corroborates those of Wijaya and Soedjono (2018), in public wastewater Surabaya City, Indonesia, but at variance with the findings of Aniyikaiye *et al*. (2019), where values ranged from 0 - 1020 mg/L in wastewater from paint manufacturing firms in Lagos Nigeria.

TSS is used to assess the quantity of suspended particles in water. It is used to express the level of pollution in wastewater. It can be used to predict the level of turbidity of water (Sulaiman *et al*., 2016). High TSS in water has the capacity to cause a corresponding increase in the rate of sedimentation of particles in water and increased sedimentation in water has the capacity to cause a reduction in the oxygen content of the water which is equivalent to sediment particles. TSS is indispensable in the control and treatment course and agreement with waste discharge guidelines (Hudson, 2010).

The measured values of conductivity within the period of 2018 varied from 63.71±27.71-389.00±263.00 µS/cm, the mean value within the period was 214.365±30.30 µS/cm. The values observed in 2019 ranged from 30.78±1.09 - 390.00±218.00 µS/cm, while the mean value within the year was 122.38±106.47 µS/cm. The

Table 3: Chemical Parameters of Wastewater at Point of Discharge in 2018.

	Chemical Parameters					
Months	**pH**	**Alkalinity (mg/L)**	**Salinity (mg/L)**	**THC (mg/L)**	**BOD (mg/L)**	**COD (mg/L)**
January	6.9±0.05	1.04±0.32	27.03±1.47	3.15±0.26	6.26±0.15	8.72±0.11
February	7.58±0.93	0.86±0.27	19.57±13.63	1.02±0.86	4.27±0.65	5.68±0.70
March	7.17±0.03	1.27±0.11	26.61±0.09	2.44 ± 0.17	5.83±0.14	7.27±0.15
April	7.46±0.05	0.93±0.48	21.66±3.24	1.68±0.11	5.03±0.39	6.45±0.55
May	7.10±0.13	1.38±0.17	26.76±5.35	1.97±1.72	5.12±1.19	8.05±1.70
June	7.23±0.12	1.30±0.81	27.03±5.67	4.35±2.46	6.13±0.09	9.48±0.036
July	7.40±0.08	1.37±0.05	29.61±12.09	2.18±1.18	9.28±4.41	12.47±5.95
August	7.28±0.01	0.70±0.02	22.84±3.67	1.82±0.50	5.78±0.45	8.71±1.02
September	7.11±0.10	0.97±0.28	30.95±8.95	1.70±1.42	1.37±1.36	3.63±1.26
October	7.27±0.13	0.95±0.06	33.21±1.40	1.38±0.01	3.90±0.48	5.84±0.65
November	7.27±0.05	1.51±0.15	17.37±10.64	3.10±0.63	4.17±0.06	5.80±0.07
December	7.34±0.11	0.70±0.03	22.83±10.18	3.88±1.43	4.30±0.29	6.30±0.42
Mean±SD	7.26±0.17	1.08±0.26	25.46±4.51	2.39±0.98	5.12±1.79	7.37±2.20

Table 4: Chemical Parameters of Wastewater at Point of Discharge in 2019

	Chemical Parameters					
Months	**pH**	**Acidity (mg/L)**	**Salinity (mg/L)**	**THC (mg/L)**	**BOD (mg/L)**	**COD (mg/L)**
January	7.31±0.20	0.70±0.01	17.67±5.95	3.94±0.26	2.77±0.45	5.35±0.46
February	7.23±0.02	1.00±0.03	32.02±0.67	3.35±0.28	3.00±0.02	5.125±0.77
March	7.76±0.50	0.63±0.01	33.71±2.67	2.50±0.19	4.84±2.52	6.67±2.76
April	7.36±0.13	0.64±0.05	23.54±0.30	1.84±0.37	4.01±0.69	3.68±1.50
May	8.37±0.06	0.61±0.14	22.18±9.18	2.38±0.30	4.88±1.17	6.51±1.09
June	7.15±0.05	0.50±0.00	36.55±4.55	1.21±0.21	4.40±1.49	6.51±0.82
July	8.93±0.07	0.28±0.18	4.08±0.26	0.82±0.13	3.06±1.05	5.35±1.04
August	7.73±0.47	0.06±0.05	14.41±1.95	0.35±0.29	3.66±0.46	5.72±0.61
September	6.95±0.01	0.85±0.47	32.75±4.94	1.15±0.78	3.68±0.01	5.34±0.02
October	7.31±0.66	0.002±0.00	15.97±11.85	1.86±1.76	3.06±1.29	5.15±0.97
November	6.71±0.51	0.10±0.10	20.77±0.96	0.55±0.45	3.51±1.62	5.67±1.35
December	6.63±0.07	1.24±0.24	59.06±37.64	2.36±1.00	4.12±2.02	6.91±1.59
Mean±SD	7.45±0.64	0.55±0.34	26.06±13.47	1.86±1.06	3.75±0.69	5.67±0.86

least value within the two-year period was observed in August 2019 and the highest was observed in March, 2019. The value of conductivity determined in the present work is lower than the 150 µS/cm limit proposed by DWA (1999). The values observed for conductivity in the present work is lower than those of Iwuozor and Emuobosa (2011), in effluents from a beer brewing industry elsewhere in Imo State, Nigeria and also those of Aniyikaiye *et al*. (2019), in wastewater discharged from paint industries in Lagos, Nigeria.

The conductivity of any medium is a measure of the ability of the medium to allow the passage of electricity through it. This capacity is dependent on the number of transporting ions present and the availability of ionic species (Julian *et al*., 2018). The low levels of conductivity observed in the present work is an indication that the wastewater contains a very low level of inorganic ions (Aniyikaiye *et al*., 2019) and also showed that the concentrations of total dissolved solids in the wastewater is minimal (Uwidia and Ukulu, 2013). When the conductivity of any wastewater is high, it increases the salinity of the receiving water body, which has a negative consequence on the ecology and thus hazardous to aquatic flora and fauna (Muhibbu-din *et al*., 2011).

The results of the chemical parameters in the wastewater effluents from the oil industry at the point of discharge are shown in Tables 3 and 4. The pH of the wastewater in the year 2018 varied from 6.9±0.05 - 7.58±0.93, with a mean value of 7.26±0.17, while the value range for 2019 was 6.63±0.07 - 8.93±0.07 and an arithmetic mean of 7.45±0.64. The lowest pH value was observed in December 2019, while the highest pH value was observed in July 2019. The pH of the wastewater discharged by the industry falls within the required value of 6 – 9, 6.5–8.5 and 5.5–9.5 by WHO (2006), FME (2011) and DWA (1999), for discharged effluents respectively. The result of pH obtained in the present study is higher than those of Iwuozor and Emuobosa (2018), who observed very acidic wastewater from the brewery industry at 2.25. The importance of pH levels in wastewater lies in the fact that it helps in the removal of both organic compounds and heavy metals during the treatment processes. When the pH shifts to alkaline levels, most metals are precipitated and easily removed as insoluble solids (Edokpayi *et al*., 2015).

The alkalinity of the effluent water varied from 0.70±0.02 - 1.51±0.15 mg/L, with an average value of 1.08±0.26 mg/L in 2018, while the 2019 value ranged from

0.002±0.00 - 1.24±0.24 mg/L and a mean value of 0.55±0.34 mg/L. The lowest value was observed in October 2019 and the highest was observed in November 2018. The alkalinity values observed in the present work is lower than the value observed in wastewater disposed of a treatment plant after treatment in Haridwar City (Uttarakhand) India (Kumar and Chopra, 2012).

The ability to neutralize acids is known as alkalinity. In any natural aquatic environment, alkalinity results majorly from the salts of weak acids such as carbonates, bicarbonates and hydroxide. Certain reactions that may be naturally or facilitated by men such as those of CO_2 and $CaCO_3$ or $MgCO_3$ can result in the production of substantial quantities of bicarbonates. Other sources of alkalinity are organic acids for example humic acid that reacts to form salts that can cause a rise in the alkalinity of the medium (Kumar and Chopra, 2012).

The salinity content of the wastewater discharged from the industry ranged from 17.37±10.64 - 30.95±8.95 mg/L and a mean value of 25.46±4.51 mg/L in 2018, while the values observed in 2019 ranged from 4.08±0.26 - 59.06±37.64 mg/L and a mean value of 26.06±13.47 mg/L. The lowest discharged value within the period of analysis was observed in the month of July 2019 and the Highest in December 2019. The observed salinity values of the present work are lower than the WHO recommended value of 2000 mg/L and also the values observed in Silver River Bayelsa State, Nigeria, where values were in the range of 8200 - 9300 mg/L (Edori *et al*., 2019).

Salinity is used to express the quantity of saltiness and salt carrying species present in the water media. The low values observed in the wastewater indicated that the presence of Na, Mg and Ca and their associated cations were low in the water discharged.

The total hydrocarbon content (THC) value in 2018 during the months varied from 1.02±0.86 - 4.35±2.46 mg/L. The mean value of THC disposed within the year was 2.39±0.98 mg/L. In 2019, THC concentrations in the wastewater varied from 0.35±0.29 - 3.94±0.26 mg/L, with a mean value of 1.86±1.06 mg/L. The highest concentration observed within the two-year period of analysis was observed in June 2018 and the lowest in August 2019. The observed values of THC in the present work is lower than 20 mg/L recommended by WHO and also those of Edori *et al*., (2019) in Silver River Bayelsa State, Nigeria, but higher than the values of Iyama *et al*. (2020), in Woji Creek.

Excess THC in aquifers inhibits the penetration of oxygen into the water, thereby causing a reduction in oxygen concentration. THC has a negative effect on aquatic animals due to its capacity to block the surface water from oxygen penetration through it and blocks the olfactory organs (Howard *et al.,* 2009). It also impacts foul odour on water.

The biochemical oxygen demand (BOD) concentrations of the discharged wastewater varied from 1.37±1.36 - 9.28±4.41mg/L and an average mean of 5.12±1.79 mg/L in 2018. The values observed in 2019 varied from 2.77±0.45 - 4.88±1.17 mg/L and a mean value of 3.75±0.69 mg/L. The lowest value of BOD within the experimental period was observed in September 2018 and the highest in July 2018. The BOD values of the used water from the oil industry in the present work conforms to FME (2011), 6 mg/L and WHO (2006), 60 mg/L recommended values. The BOD values of the wastewater in the present work is higher than the values observed in paint industry effluents in Lagos, Nigeria (Aniyikaiye *et al*., 2019), but lower than those of Gupta *et al*. (2017,) in wastewater from bleach and dye manufacturing industry at Kalikapur, West Bengal, India and also those of Iwuozor and Emuobosa (2018), in used water from brewery industry in Imo State.

The factors that influence high BOD content in water systems are the presence of materials of organic origin such as leaves of dead and decaying plants and animals, waste products of plants and animal sources, discharge from wastewater treatment plants, food processing plants, woody debris, animal manure, and urban stormwater runoff. High BOD reduces water quality by reducing the amount of dissolved oxygen (DO) in water. The higher the concentration of BOD in water, the greater the rate of oxygen depletion takes place in water and reduced oxygen in water causes mortality of aquatic lifeforms (Chigor *et al*., 2013). High levels of BOD is traceable substantial release of effluents, domestic sewage, crops, and animal waste from homes of individuals and industries (Fatoki *et al*., 2003).

Chemical oxygen demand (COD) values observed in 2018 ranged from 3.63±1.26 - 12.47±5.95 mg/l and a mean value of 7.37±2.20 mg/L were observed during the year. In 2019, the values ranged from 3.68±1.50 - 6.91±1.59 mg/L, with a mean value of 5.67±0.86 mg/L. The least and highest values of COD within the two years were observed in September and July respectively in 2018. The observed COD values from the present work are lower than the FEPA (1996) value of 80 mg/L, those of Benit and Roslin, (2015), in wastewater collected from Nagercoil Town, Kanyakumari District, Tamilnadu, India, where COD values in the wastewater ranged from 506.9 - 602.9 mg/L and also lower than the values observed in the Sudanese fermentation industry, where COD content of the wastewater varied from 80-4500 mg/L (Abdel *et al*., 2010).

In the presence of strong oxidizing agents, nearly all organic compounds can be oxidized in a prevalent acidic medium. Chemical oxygen demand (COD) examines the amount of oxygen that is equal to the concentration of organic matter present in a sample that can be oxidized in the presence of a strong chemical oxidant. It is a useful tool in the determination of the extent of pollution and toxicity of aquatic environments especially when there are biological organisms that are resistant to degradation. Like BOD, COD also takes into consideration the amount of oxygen used up in wastewater or any aquatic medium and also measures the quantity of available organic constituents present in the medium (Lokhande *et al*., 2011).

Conclusion

All over the globe, different countries had set up different regulatory agencies to control the nature of waste and their concentrations before discharged into the ecosystem. The results obtained in the present work on the wastewater from the oil industry showed that all the examined parameters were within the discharge acceptable limits by WHO, FME, FEPA and DWA. This is an indication that the industry probably followed due guidelines for the treatment of their wastewater before discharging it to the nearby water body. The study revealed that the effluents from the industry may not constitute any danger to the environment.

REFERENCES

Abdel MES, Abdel WMY, Abdel MM (2010). Chemical, physicochemical and physical properties of wastewater from the Sudanese fermentation industry (sfi). Fourteenth International Water Technology Conference, IWTC 14 2010, Cairo, Egypt, 305 - 315.

Agoro M, Okoh, OO, Adefisoye MA, Okoh AI (2018). Physicochemical properties of wastewater in three typical South African sewage works. Polish Journal of Environmental Studies, 27(2): 491-499.

Benit N, Roslin AS (2015). Physicochemical properties of wastewater collected from different sewage sources. International Journal of Innovative Science, Engineering and Technology, 2(11): 691-696.

Chauhan RK (2014). Physico-chemical analysis of untreated sewage water of Ladwa town of Kurukshetra District of Haryana and need of waste water treatment plant. International Journal of Current Microbiology and Applied Science, 3(3): 326-333.

Chigor VN, Sibanda T, Okoh AI (2013). Variations in the physicochemical characteristics of the Buffalo River in the Eastern Cape Province of South Africa. Environmental Monitoring and Assessment, 185 (10): 8733.

Department of Water Affairs (DWA) (1999). General and Special Authorisation. Government Notice: Government Gazette No. 20526 8 October 1999.

Dhingra P, Singh Y, Kumar M, Nagar H, Singh K, Meena LN (2015). Study on Physicochemical Parameters of Waste Water Effluents from Industrial areas of Jaipur, Rajasthan, India. International Journal of Innovative Science, Engineering and Technology, 2 (5):874-876.

Edokpayi JN, Odiyo JO, Msagati TAM, Popoola EO (2015). Removal Efficiency of faecal indicator organisms, nutrients and heavy metals from a Peri-Urban wastewater treatment plant in Thohoyandou, Limpopo Province, South Africa. International Journal of Environmental Research and Public Health, 12: 7300–7320.

Edori OS, Iyama WA, Amadi MC (2019). Status of Heavy Metals Contamination in Water from Elelenwo River, Obio-Akpor, Rivers State, Nigeria. Direct Research Journal of Chemistry and Material Science, 6(3): 25-31.

Edori OS, Kieri BSI, Festus C (2019). Physicochemical Characteristics of Surface Water and Sediment of Silver River, Southern Ijaw, Bayelsa State, Niger Delta, Nigeria. American Journal of Environmental Science and Engineering, 3(2): 39-46.

Edori OS, Nna PJ (2018). Determination of Physicochemical Parameters of Effluents at Discharge Points into the New Calabar River along Rumuolumeni axis, Niger Delta, Nigeria. Journal of Environmental and Analytical Toxicology, 8(3): DOI: 10.4172/2161-0525.1000585.

Fatoki OS, Gogwana P, Ogunfowokan AO (2003). Pollution assessment in the Keiskamma River and in the impoundment downstream. Water SA. 29 (2): 183,

Fatta-Kassinos D, Kalavrouziotis I, Koukoulakis P (2011). The risks associated with wastewater reuse and xenobiotics in the agroecological environment. Science and Total Environment, 408 (19): 3555.

FEPA (1996). Water quality monitoring and environmental status in Nigeria, FEPA Monograph 6, FEPA, Abuja, p 239.

Federal Ministry of Environment (FME) (2011). Federal Republic of Nigeria Official Gazette for National Environmental Surface and Groundwater Quality Control. Regulations; The Federal Government Printer: Lagos, Nigeria, Volume 98, pp. B693–B728, FGP 71/72011/400 (OL 46).

Gupta BG, Biswas JK, Agrawal KM (2017). Physico-Chemical Parameters, Water Quality Index and Statistical Analysis of Surface Water Contamination by Bleaching and Dyeing Effluents at Kalikapur, West Bengal, India. Journal of Environmental Science and Pollution Research, 3(2): 177-180

Howard IC, Gabriel UU, Horsfall M (2009). Evaluation of total hydrocarbon levels in some aquatic media in an oil-polluted mangrove wetland in the Niger Delta. Applied Ecology and Environmental Research, 7 (2): 111-120.

Hudson K (2010). Operational Performance of the Anaerobic Baffled Reactor Used to Treat Wastewater from a Peri-Urban Community.

Iwuozor KO, Emuobosa EG (2018). Physico-Chemical parameters of industrial effluents from a brewery industry in Imo State, Nigeria. Advanced Journal of Chemistry-Section A, 1(2): 66-78.

Iyama WA, Edori OS, Nwagbara VU (2020). Assessment of the pollution load of the Woji Creek water body, Port Harcourt, Rivers State, South-South, Nigeria. International Journal of Advanced Research in Chemical Science, 7(1): 1-8.

Joel OF, Akinde BS, Nwokoye CU (2009). Determination of Some Physicochemical and Microbiological Characteristics of Sewage Samples from Domestic, House-boat and Off-shore Facilities Discharge Point. Journal of Applied Science and Environmental Management, 13(3): 49-52.

Julian KT, Marianne S, Shaun R (2018). Contaminated groundwater sampling and quality control of water analyses. Environmental Geochemistry, 2nd ed.; British Geological Survey: Nottingham, UK, pp. 25-45.

Kumar V, Chopra AK (2012). Monitoring of physicochemical and microbiological characteristics of municipal wastewater at a treatment plant, Haridwar City (Uttarakhand), India. Journal of Environmental Science and Technology, 5(2): 109-118.

Lokhande RS, Singare PU, Pimple DS (2011). Study on physicochemical parameters of wastewater effluents from Taloja industrial area of Mumbai, India. International Journal of Ecosystem, 1(1): 1-9.

Morrison GO, Fatoki OS, Ekberg A (2001). Assessment of the impact of point source pollution from the Keiskammahoek sewage treatment plant on the Keiskamma River. Water S A., 27: 475-480.

Muhibbu-din OI, Aduwo AO, Adedeji AA (2011). Study of physicochemical parameters of effluent impacted stream in Obafemi Awolowo.

Uwidia IE, Ukulu HS (2013). Studies on Electrical Conductivity and Total Dissolved Solids. Concentration in raw domestic wastewater obtained from an estate in Warri, Nigeria. Greener Journal of Physical Sciences, 3: 110 - 114.

Singh SN, Srivastav G, Bhatt A (2012). Physicochemical determination of pollutants in wastewater in Dheradun. Current World Environment, 7(1): 133-138.

Sulaiman AA, Attalla E, Sherif MAS (2016). Water Pollution: Source and Treatment. American Journal of Environmental Engineering, 6: 88-98.

Wijaya IMW, Soedjono ES (2018). Physicochemical Characteristic of Municipal Wastewater in Tropical Area: Case Study of Surabaya City, Indonesia. IOP Conference Series: Earth and Environmental Science, 012018 doi :10.1088/1755-15/135/1/012018 1234567890.

World Health Organisation (WHO) (2006). A Compendium of Standards for Wastewater Reuse in the Eastern Mediterranean Region; Regional Office for the Eastern Mediterranean Regional Centre for Environmental Health Activities CEHA: Los Angeles, CA, USA, pp. 1–19.

Wokoma OAF, Edori OS (2017). Heavy metals content of an oily wastewater effluent from an oil firm at the point of discharge. International Journal of Chemistry, Pharmacy and Technology, 2 (4):154-161.