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Original Research Article

AN ASSESSMENT OF THE PHYSICAL CHARACTERISTICS OF INDUSTRIAL WASTE WATER DISCHARGE INTO KADUNA RIVER

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Abstract:
An assessment of the physical characteristics of industrial wastewater discharge into Kaduna River was carried out. Daily concentration of Turbidity, Temperature, Colour, Electrical conductivity and Total solids were converted to mean monthly. From the analysis conducted on bimonthly and monthly basis, it was observed the highest mean concentration of Turbidity (143 NTU) was recorded for the bimonthly while (133NTU) was for the monthly. The highest mean Temperature of 31.26^0C was observed for bimonthly and 31.27^0C was the temperature for the monthly. The highest mean color concentration level of $38.4H^0$ recorded for bimonthly while $38.5H^0$ was for the monthly. The highest mean Electrical conductivity at 3700µs/cm recorded for the bimonthly while 3090µs/cm for the monthly reading was recorded. Total dissolved solids value of 335.1mg/l for bimonthly reading was recorded in August and 272.7mg/l monthly mean concentration was recorded monthly. From the analysis, it can be adduced that Turbidity, color and Total solid concentration increases during wet weather flow mainly due to lateral inflow while temperature and Electrical conductivity concentration increases during dry weather flow.

Keywords: Physical, Wastewater, Discharges, Concentration, Effluent.

Introduction:

Since Nigerian independence in 1960, there has been concerted effort to exploits the Nations various resources to meets various human needs. This has led to the rapid technological development and industrialization. Industrialization have been concentrated in the urban cities and at such location where the absorptive capacities of the natural environment can be easily exhausted, resulting into serious degradation of the environment resources of the area as considered in the report by[1]. Furthermore,[1] observed that about 80% of major industries in Nigeria are concentrated In Port Harcourt, Kano, Lagos and Kaduna. The physical, chemical and biological composition of the effluent waste discharges into Kaduna

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river analyzed by [1] indicate that effluent from textile industry has high concentration of Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), and color. The food and beverages industry discharges have high BOD,COD and solid waste, while the petrochemical effluent have high level of oil and grease, COD and a low BOD. According to a report by [2], the industries in Kaduna discharges over $500m^3/d$ of untreated effluent into the Kaduna River. This has led to massive pollution of both surface and groundwater resources, attesting to the assertion by [3] that wastewater pollution has always been a major problem throughout the world. Also, according to the report by [4], that globally, the effluent that are discharge from wastewater treatment systems represent one of the largest source of pollution.[4] Suggested that wastewater treatment should be a vital component of any community and that the processes of wastewater treatment can be categorized into chemical and biological.[5] investigated the effectiveness of immobilized cells of *F oxysporium* in the treatment of textile effluent as well as bio sorption of heavy metals from textile wastewater discharge into Kaduna River. Kaduna is none of the few industrialized cities in Nigeria with over ninety two (92) industries out of which twenty seven are classified as wet effluent discharges. The aim of this research is to characterize the physical parameters and their concentration and also to suggest possible ways handling it.

The Study Area

The global location of Kaduna State is between Latitudes 90 and 140 North of the equator and Longitudes 70 and 100 East of Greenwich meridians. It occupies a landmass of about 70,210 square kilometers on the map of Nigeria as contained in Nigeria Arts and Culture Directory Project (NACD) report. The topography is that of undulating plateau.

Climate

Kaduna State has two distinct seasons. The dry season last from November to mid-April while the rainy season which is cool last between 5-6 months starting from mid-April. The states extents from the tropical grassland known as Guinea Savana to Sudan Savana. The vegetation is thick and grasses about 3.6 meter tall with big trees which grow shorter towards the Sudan Savana.

Relief

The Kaduna River flowing from East to West through the state drains an area of 65,000 square kilometers and is characterize by its steep slopes and fast floods. Kaduna River is the only major water sources in Kaduna state and has its sources in the highland around the Jos plateau; it is however fed by many tributaries and in turn runs into many smaller rivers.

Effluents from industrial discharges were collected at the following locations: Kudenda Drain (KD), Makera Drain (MD), Kaduna North Water Works (KNWW), Kabala West (KW), Kaduna South Water Works (KSWW), and River Kaduna Bye-Pass Bridge (RKBB). The analysis of samples at KNWW located upstream of the industrial area serves as control. The sampling points are shown in Fig 1.

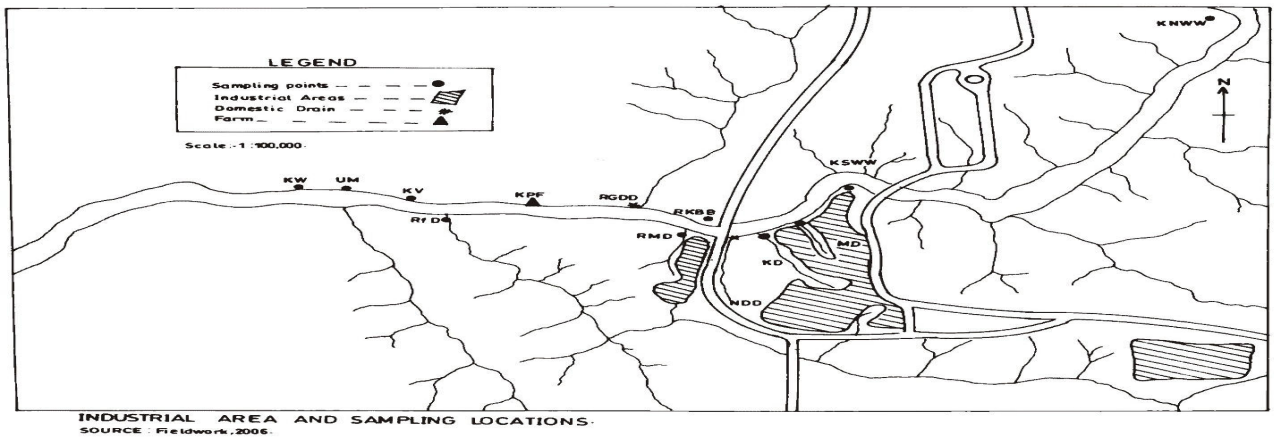


Fig 1 Sampling Locations

Materials and Method

The process of sampling of the wastewater for analysis involves the following;

1) Plastic transparent containers (1 litre/parameter) thoroughly washed and sterilized using Ultraviolent (UV) light.
2) The plastic containers were clearly labelled for identification
3) The collected samples were kept cool in an insulated container and taken to the laboratory for analysis
4) The samples were collected at mid-stream where complete mixing is assumed to have taken place.

The procedure of the sampling involves dipping the container downward below the surface of water to about 300mm the container was filled to capacity and stoppered.

The following physical characteristics (parameters), color, temperature, electrical conductivity, turbidity and total solids were analyzed based on the Standard Methods of Examination of Water and Wastewaters [6].

The following apparatus and glassware's were used for the analysis;

Turbid meter: HACH Model 2100A

Lovibond Comparator with Color disc/cells: AOCS- Tintometer colour 0.3R

pHMeter, Thermometer (EL 82-5243): pH Model 292k2 manufactured by PYE England, Thermometer manufactured by Gallenkamp England

Conductivity Meter

Evaporating dish (EL 82-1970), Water bath (Constant temperature JULABO U3), Oven (GENLAB, EL 78-1215), Desiccators IS 6128, Analytical Balance (ADA 189), Graduated Cylinders, Dish Tongs, Gooch Crucibles, Filter (EL 82-7861), Vacuum Pumps, Crucible tongs (EL 82-3320), Forceps Smooth-tipped.

Glass wares Beakers, Burette, Pipette (EL 82-1240), Conical Flask, Calibrated Cylinders, Funnel, and Evaporating Dish. All manufactured by Wheaton USA, Peterson Candy International and Borosilicate England.

Methods

i. Turbidity

Procedure

1. Switch on the turbid meter and allow to warm for 10 minutes.
2. Pour water sample into one cell and compare with the standard cell provided.
3. The standard cell, which closely march the water sample, is used to calibrate the turbid meter.
4. The standard cell placed with water sample was inserted and then covered with the black cell.
5. The turbidity value was recorded in NTU.

ii. Temperature

Procedure

1. Switch on the pH meter and preset to the temperature mode.
2. Distilled water was poured into a beaker and used to rinse the probes.
3. Sample water was poured into the second beaker to a mark of 100ml
4. Probe was then dipped into the sample water and the reading recorded in oc.

iii. Colour

Procedure

1. One of the cells was filled with distilled water to the mark and placed in the left side of the comparator.
2. The second cell was filled to the mark and placed on the right side of the comparator.
3. The colour disc was slided and rotated until a colour march facing the direction of the source of light.
4. From the eye-piece of the comparator, the reading was taken from the lower light angular hole and the number on the disc recorded in Hazen unit.

iv. Electrical conductivity

Procedure

1. Rinse beakers with distilled water
2. Fill one beaker with distilled water and fill the second beaker with the sample water.
3. Rinse the electrodes with distilled water.
4. Dip electrodes in water sample and record the electrical conductivity value in µs/cm.

v. Total Solids (Dissolved and Suspended)

-Dissolved Solids

Procedure

1. Clean the evaporating dish and dry in an oven at 100oC for 20 minutes
2. Remove and cool the evaporating dish in a desiccator for 30 minutes and then weigh the empty dish

3. Pour 50ml of effluent in the evaporating dish, heat until all the water dries up
4. Transfer the evaporating dish to the oven to dry completely at 100oC for 20 minutes
5. Remove dish and cool in a desiccator, then weigh with residue

The Dissolved Solid is the difference between the dish weighed with residue (dr) and the weighed empty dish (de). (dr – de)mg/l

-Suspended Solids

Procedure

1. Dry the filter paper in an oven at 100oC for 20 minutes
2. Cool the filter paper in a desiccator for 30 minutes
3. Weigh filter paper as initial reading
4. Fold the filter paper to funnel shape and put in a funnel
5. Filter 50ml of the water sample
6. Oven dry the filter paper with residue at 100oC for 20 minutes
7. Cool filter paper with residue in a desiccator for 30 minutes
8. Weigh the filter paper with residue as the final reading

The Suspended Solids is the difference between the final (filter + sample) reading fs and the initial (filter) f reading. (fs – f) mg/l

Total Solids therefore is the summation of the Dissolved Solids and the Suspended Solids mg/l of 38.4H^{o}for Series 1 and in February, 38.5H^{o}for Series 2. The sampling point for this daily concentration in April, is at the Kakuri Drain (KD), with 87H^o for Series 1. The sampling point for the daily concentration in February, is at the Kakuri Drain (KD), with 27.4H^o for Series 2.

The lowest mean colour concentration is recorded in July, with 28H^o for Series 1 and 91H^o for Series 2. The sampling point for this daily concentration is at the Kaduna North Water Works (KNWW), with 58H^o for Series 1 and 53H^{o}for Series 2.

Results and Discussions

Turbidity

The highest mean concentration is recorded in September at 143NTU for Series 1 and in March at 145NTU for Series 2. The sampling points in September are at the Kudenda Village (KV), with the daily concentration of 182NTU for Series 1. However, in March, the sampling point is at the Makera (MD), with the daily concentration of 44NTU for Series 2.

April and February recorded the lowest mean concentration of 38.8NTU and 38.4NTU for Series 1 and Series 2 respectively. The Kaduna North Water Works (KNWW) recorded the lowest daily concentration of 26NTU in April and in February with the daily concentration of 28NTU, for Series 1 and Series 2 respectively.

Temperature

The highest mean temperature is recorded in the month of May at 31.26^{o}C for Series 1 and in April 31.27^{o}C for Series 2. In May, the Kakuri Drain (KD) recorded the highest daily temperature of 44^{o}C for Series 1. In April, the Kakuri Drain (KD) also recorded the highest daily temperature of 45^{o}C for Series 2.

The lowest mean temperature is recorded in October at 24.76^{o}C and 23.9^{o}C for both Series 1 and Series 2. The sampling points with the lowest daily temperature are the Kaduna North Water Works (KNWW), with 23^{o}C for both Series 1and Series 2 and at the also Kabala West (KW), with 23^{o}C for Series 2.

Colour

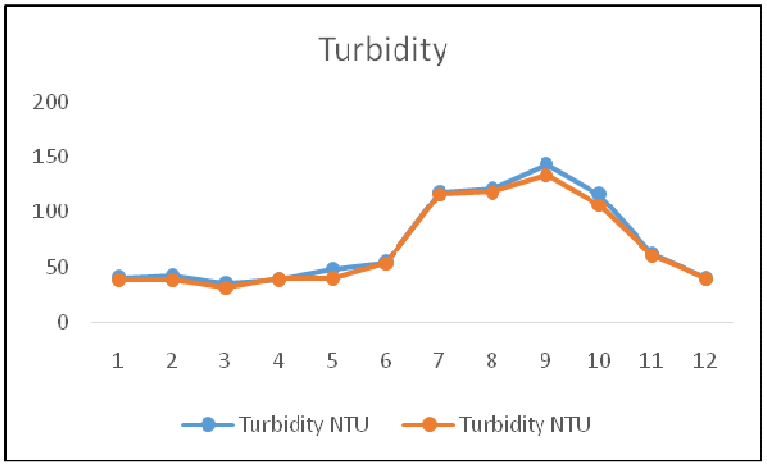
The highest mean colour concentration is recorded in April, with the concentration level

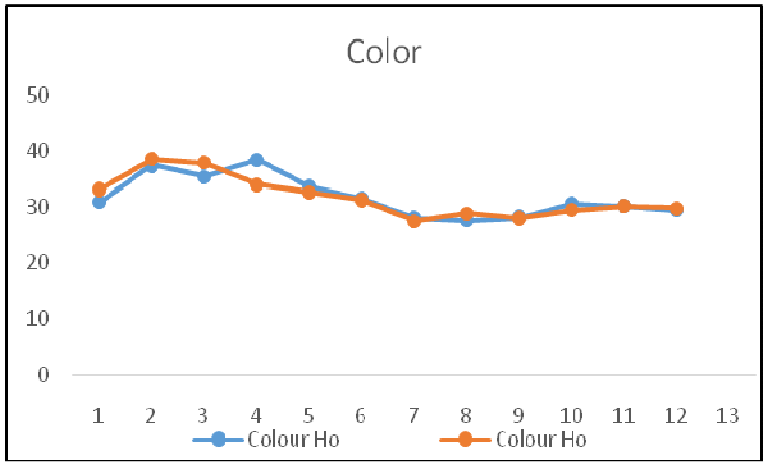
Electrical Conductivity

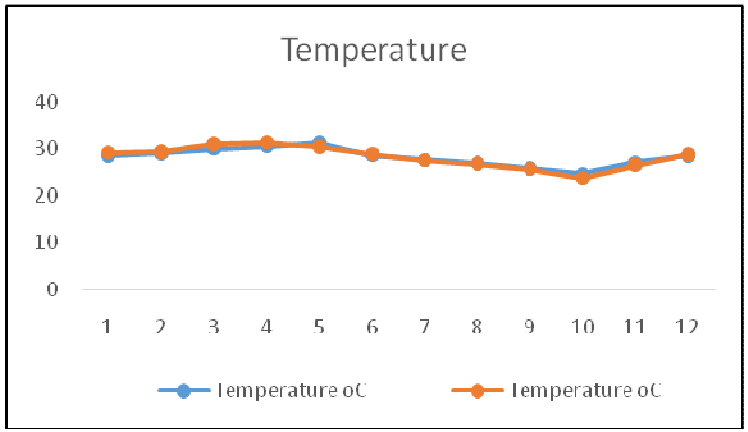
The highest mean electrical conductivity is recorded in February at 3700µs/cm for Series 1 and in January at 3090µs/cm for Series 2. The sampling point for the daily concentration in February is at the Kakuri Drain (KD), with 6980µs/cm for Series 1, and in January, at the Makera Drain (MD), with 4960µs/cm for Series 2.

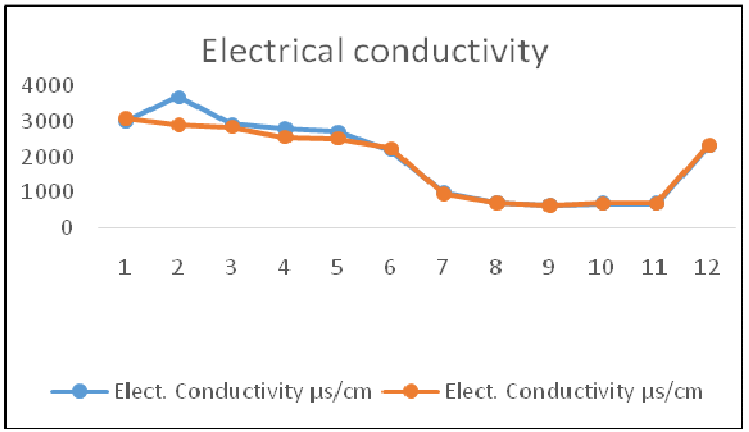
The lowest mean electrical conductivity is recorded in September with 638µs/cm for Series 1 and 626.8µs/cm for Series 2. The lowest concentration occurred at the Kaduna North Water Works (KNWW), with 351µs/cm for Series 1 and 354µs/cm for Series 2

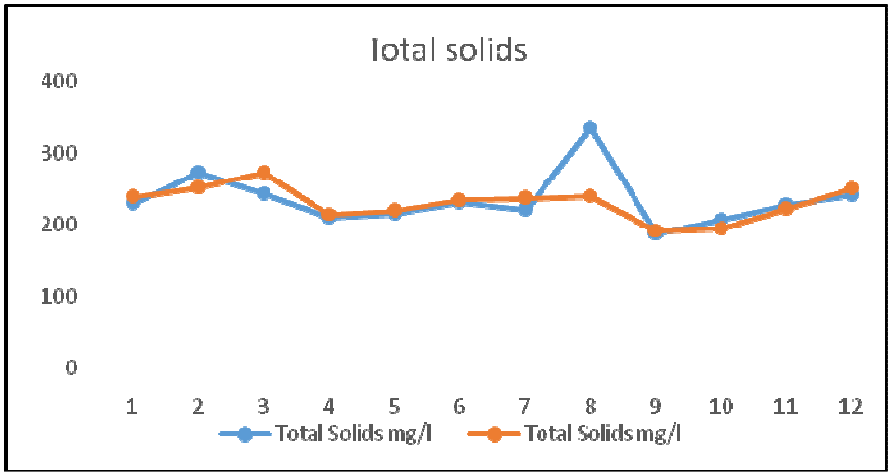
PARAMETER													
PHYSICAL CHARACTERISTICS		Series	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Turbidity NTU	Bimonthly	1	40.6	42	35.739	38.8	47.8	54.1	118.4	121.6	143.1	116.5	62.2	39.7
	Monthly	2	38.5	38.4	31.65	39	39.9	53.1	116.6	118.1	133.3	106.3	60.2	39.7
Temperature ^{o}C	Bimonthly	1	28.5	29.05	29.98	30.57	31.26	28.66	27.65	26.91	25.95	24.76	27.1	28.5
	Monthly	2	29.12	29.35	30.89	31.27	30.35	28.9	27.52	26.87	25.75	23.9	26.6	28.8
Colour H^{o}	Bimonthly	1	30.9	37.4	35.4	38.4	33.6	31.6	28	27.58	28.1	30.6	30.16	29.36
	Monthly	2	33.1	38.5	37.9	33.9	32.5	31.2	27.4	28.7	27.9	29.4	30.1	29.7
Elect. Conductivity µs/cm	Bimonthly	1	3025	3700	2939	2805	2713	2196	1002	711.4	638	688.5	689.1	2312
	Monthly	2	3090	2898	2851	2559	2525	2239	965.4	710.9	626.8	683.8	686	2324.2
Total Solids mg/l	Bimonthly	1	229.7	272.3	242.6	210	215.5	231.7	221	335.1	187.6	206.9	227.5	241.6
	Monthly	2	238.8	252.1	272.7	213.9	219.7	234.1	237.2	239.8	191.5	194.4	222.5	250.8






Temperature
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12
Temperature oC
Temperature oC


Electrical conductivity
4000
3000
2000
1000
0
1 2 3 4 5 6 7 8 9 10 11 12
Elect. Conductivity µs/cm
Elect. Conductivity µs/cm


Total solids
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12
Total Solids mg/l
Total Solids mg/l

Total Solids

The highest mean concentration for total solids is recorded in August with 335.1mg/l for Series 1 and in March with 272.7mg/l for Series 2. The sampling points with the highest daily concentration occurred at the Kudenda Village (KV), with 345mg/l for Series 1 and at the River Kaduna Bye-pass Bridge (RKBB), with 376mg/l for Series 2

The lowest mean concentration occurred in September, with 187.6mg/l for Series1 and 191.5mg/l for Series 2. The sampling point with the lowest daily concentrations is at the Kaduna North Water Works (KNWW), with 103mg/l for Series 1 and 112mg/l for Series 2.

Although, disposal of various waste materials into Rivers, estuaries and Marine water is not a modern phenomenon, the practice has been used as preferred disposal options as considered in studies by [7,8]. Disposal of effluent by direct discharge into water bodies introduces organic and inorganic contaminants into the aquatic habitat, thus resulting into interference with the delicate use of the natural resources. Determination of the concentrations of the contaminants is important for an effective treatment facility planning and development. This studywas therefore aimed at assessing the physical parameters, and their concentrations

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