

## Parametric Index Analysis of Effects of Effluents and Solid Wastes on Ukwaka Streams, Nnewi, Nigeria

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**Abstract:** Many industries in Nigeria discharge their wastewater into surface waters without any form of treatment. Equally, solid wastes were indiscriminately dumped into streams. These contribute a lot of toxic wastes to stream. Hence, this study was carried out to investigate the Parametric Index Analysis of Combined Effects of Effluents and Solid Wastes on Streams. Sections of Ukwaka stream along its course were studied over a period of six months to determine the effects of effluent and solid wastes discharges on the water quality of the stream. Water samples were collected from four different sites: A, B, C, and D along the stream. Samples were analyzed weekly for a number of physicochemical parameters using standard procedure and Atomic Absorption Spectrophotometer (AAS) used for the heavy metal analysis. Pollution levels of water samples analyzed were compared with international standard. The results revealed that there were variations in the level of pollution in each site which could be traced to seasonal variations. Both the physical and chemical qualities of the water at the sites were impaired. Pollution level was found to be significantly high in dry season but relatively low in rainy season. The with site C been the most polluted site

**Keyword:** Analysis, Effects, Effluents, Index, Parametric, Solid Wastes

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### I. Introduction

Water is the most essential requisite that nature provides to sustain life for plants and animals, and also has tremendous role in every mode of human life [1], [2]. According to [3], water is a vital commodity and its sources include rivers, streams, lakes, wells, boreholes, spring etc. [4], asserted that rivers are among the oldest water bodies in the world. In most urban-rural communities in the developing countries especially the Sub-Saharan Africa, surface waters have been the most available sources of water used for domestic purposes. Wastes entering these water bodies are both in solid and liquid forms. As a result, water bodies which are major receptacles of treated and untreated or partially treated industrial wastes have become highly polluted [5]. Industrialization is considered the cornerstone of development strategies due to its significant contribution to the economic growth and human welfare, but it carries inevitable costs and problems in terms of pollution of the air and water resources [6].

According to the [7] large numbers of water bodies in developing nations of the world are grossly polluted. In Nigeria, pollution of water bodies is further worsening with lack of adequate environmental monitoring schemes; weak enforcement of environmental regulations; and worst of all bribery and corruption [8]. According to [9], [10], and [11], many streams and rivers in Nigeria get polluted as a result of the discharge of untreated wastewater and other organic wastes directly into them. Contributing, [12] pointed out that river pollution is becoming a central issue in water management in Nigeria. [13] affirmed that the water quality situation therefore becomes very critical in these countries and of great environmental and public health concerns. Numerous studies have been and are being conducted to help define this problem; to determine the amounts of pollutant substances released to the environment, their sources, their impacts, and possible means of control [14], [15].

Based on the [7], pollution of surface water could have consequential impact on man either directly or indirectly since less than 1% of the world's freshwater, about 0.007% of all water on earth is readily accessible for direct human use. To buttress the above, [16], observed that industrial effluents mostly contain heavy metals, acids, hydrocarbons and atmospheric deposition. The type, source and the persistence nature of this effluent characterized by their toxic, deleterious nature can boost or enhance the growth and presence of micro-organism or pathogens such as bacteria, fungi, virus and protozoan [17]. Such anthropogenic activities includes release or discharge of agricultural waste, wastewater from agro allied industries, refineries, human and animal

waste including wood waste [17], [18]. In their contribution, [19] pointed out that African and Asian countries are experiencing rapid industrial growth and this is making environmental conservations a difficult task.

### 1.1 Water Quality Parameter

Globally, the health of organisms especially man depends on the quality of water at his domain. The quality of water is therefore an issue of great environmental concern. According to [20], water quality is determined by both natural and anthropogenic forces. The natural forces include precipitation rate, weathering process and soil erosion, while the anthropogenic forces are urban and agricultural activities such as domestic, municipal, industrial and agricultural wastes [21]. Contributing to the above, [22], asserted that there is need to assess water quality so as to proffer guidelines for its sustainable usage and make corrective steps to ensure its quality since it is of necessity to man, animal and plant. The common indicators for assessing water quality in Nigeria are temperature, pH, biological oxygen demand, turbidity, dissolved oxygen, ammonia, nitrogen and coli form counts [23]. However, the important physical and chemical parameters influencing the aquatic environment are pH, nutrient, temperature, salinity, dissolved oxygen and biochemical oxygen demand, chemical oxygen demand, colour, flow velocity. Others are total suspended and dissolved solids, total alkalinity and acidity and heavy metal contaminants. These parameters are the limiting factors for the survival of aquatic organisms [24, [25], [26]. In their contribution, [27] pointed out that a change in the water chemistry due to surface water contamination can negatively affect all levels of an ecosystem.

When the concentrations of these parameters are high in the body of water above the natural threshold values such that it becomes injurious to man, the water is said to be polluted. Though it is difficult to understand the biological phenomenon fully because the chemistry of water reveals much about the metabolism of the ecosystem and explain the general hydro biological relationship [28]. According to [29] the quality of water is an attribute that affects the biodiversity (flora and fauna) of aquatic systems. The physical and chemical properties of water immensely influence its uses, the distribution and richness of the biota [30], [31].

### 1.2 Water Pollution

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water making it unfit for intended use [32]. According to [33], [9], water pollution occurs when unwanted materials with potentials to threaten human and other natural systems find their ways into rivers, etc. The pollutants are usually pathogens, silt and suspended solid particles such as soils, sewage materials, disposed foods, cosmetics, automobile emissions, construction debris [34]. Careless disposal of untreated industrial waste on surface water might affect the physical, chemical and biological characteristics of river ecosystem. Untreated waste water from industries discharge on surface water is the leading cause of high biochemical oxygen demand, nitrate, phosphate and low oxygen contents on river [35]. Effluent has been linked to numerous environmental pollution problems ranging from long term environmental degradation to increased incidence of water borne disease [36].

### 1.3 Industrial waste and its composition.

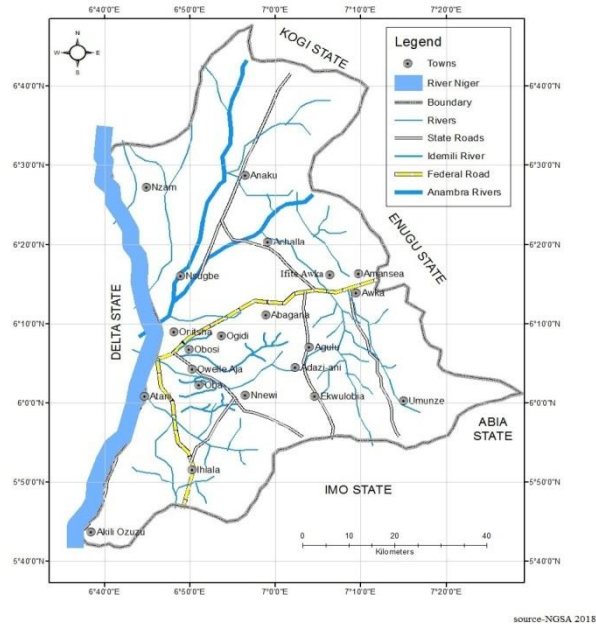
Effluent is a wastewater, treated or untreated, that flows out of a treatment plant, sewers, or industrial outfall. It is a broad term that may be used to describe any solid, liquid or gaseous product in a treated or untreated condition. Industrial effluents contain toxic and hazardous materials from the wastes that settle in river water as bottom sediments and constitute health hazards to the urban population that depend on the water as source of supply for domestic uses [37]. It could also be described as water containing dissolved and suspended solids from municipal or industrial sources. It is dilute mixture of various wastes from residential, commercial, and industrial and other public places [38]. It is about 99% water by weight. The characteristics of properties of wastewater can be classified into (i) Physical characteristics (ii) Chemical characteristics (iii) Biological characteristics [39]. Untreated wastes from processing factories located in cities are discharged into inland water bodies resulting to stench, discoloration and a greasy oily nature of such water bodies [40], [41]. Such pollutants can endanger public health by being incorporated in the food chain or being released into overlying water layers which serve as drinking water supply.

## II. Materials and Methods

### 1.3 Study area Description

This study was carried out in Umudim at Ukwaka stream which is located in Nnewi town, about 500m to the Uru Industrial Estate. Nnewi is located about 22 km south east of Onitsha. It lies in the latitude of 6° 1' N of the equator and 6° 55' E [42]. It has altitude that ranges from 105m to 300m above sea level [43], [44]. Nnewi town is indicated in map of Anambra state, (Fig. 2.1). It is a commercial city in Anambra state, in the south east of Nigeria. Its commercial nature influences its rapid urbanization [45]. Generally, the soil is composed mainly of iron rich tropical soils which may be in the form of loamy clay, and sandstones. The climate is hot and

humid; Nnewi has two major seasons namely: raining season (April to October) and dry season (November to March). The annual rainfall ranges from 165 mm in April to 1025 mm in September. The mean annual temperature ranges from 13°C in February to 22°C in October [44]. The study area (Ukwaka stream) showed in Figures 2.2 and 2.3 is a unique place where industrial effluents from Chicason Group of Industries and solid wastes are dumped regularly in an unscientific manner into the stream. Fig. 2.4 shows Ukwaka stream with the coordinates of the sampling points.



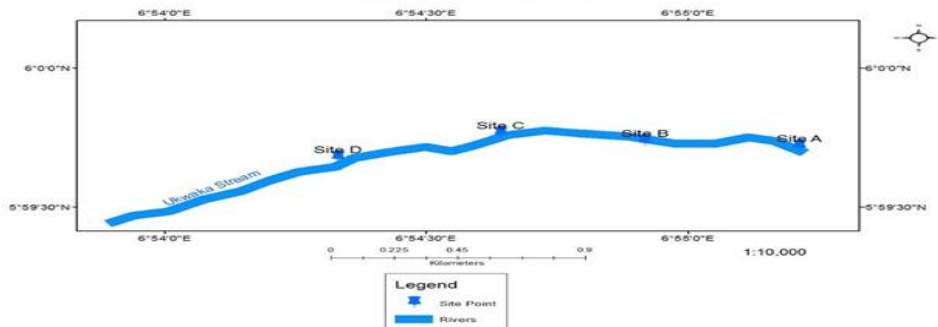
**Fig. 2.1: Map of Anambra showing major towns**



**Fig 2.2 Solid Wastes being dumped into the stream.**



**Fig 2.3 Solid Wastes in the stream**



**Fig. 2.4 Sampling points with GPS positions: A (6.820 °E, 5.885 °N); B (6.915 °E, 5.996 °N); C (6.911 °E, 5.996 °N); D (6.906 °E, 5.995 °N).**

#### 1.4 Outline of Methodology



**1.4.1 Water Sampling and Preservation procedure**

The water samples were collected from four different points (Sites A, B, C, and D) of the Ukwaka. Solid wastes are dumped at the bank of the stream just before site C.. The Samples were collected in 1 litre plastic bottles at various respective points/ sites. They were taken from the mid-stream at approximately **0.20** meters below the surface. Collective samples of effluent from the industries were collected from outlet of where the effluent emptied into the public drainage. These effluent samples were collected monthly in the period of this project while the samples of stream water from the four different points (sites) were collected every week for a total period of six months starting from July to December 2017. The sampling points are as shown in **Figures 2.5 to 2.11**. These were: (A) the point where the effluent entered the stream at **0m** distance, (B) **300m** away from the point of discharge into the stream, (C) **600m** away from the point of discharge into the stream and (D) **900m** away from the point of discharge into the stream. The collections were done on the first day of every week between 8.00 am and 12 noon.



**Fig 2.5**Ukwaka stream at point 0m distance in July



**Fig 2. 6** Ukwaka stream at point 300m in July



**Fig 7** Ukwaka stream at point 300m in Dec



**Fig 8** Ukwaka stream at point 600m in July



**Fig 9** Ukwaka stream at point 600m in Dec



**Fig 10 Ukwaka stream at point 900m in July**



**Fig 11 Ukwaka stream at point 900m in Dec**

To provide necessary information for each sample taken, they are collected into appropriately welllabelled plastic bottles with a unique identification numbers as shown in **fig 2.12**. After collection, the bottles containing samples were sealed immediately to avoid exposure to air. The dates of collection, location were recorded in the note book and each sample collected was labeled separately. Prior to this, all the bottles were washed and rinsed three times with the water to be sampled. They were transported within 48 hours to the laboratory, preserved according to the standard method of American Public Health Association (APHA), ready for the Physical, Chemical and Heavy Metals parameters analyses. A total of **96** water samples, **6** Effluent samples were analysed for **18** parameters in each.



**Fig. 2.12 samples in the containers**

#### **1.4.2 Determination of physicochemical characteristics**

Physicochemical characteristics determinations were carried out according to the Standard Methods for the Examination of Water and Waste water [46]. Various standard methods were followed and a number of sophisticated instruments were used. Water colour was observed by naked eyes and odor was felt with nose. The water temperatures, electrical conductivity (EC), were taken immediately in the field by using designated pocket instruments, while others were analyzed in the laboratory according to standard methods. The analyses were carried out at the Springboard laboratories, Awka, Nigeria.

#### **2.3 Sample Storage and Preservation**

Temperature, pH and conductivity were measured immediately after sample collection. The samples were collected in a container and preserved according to the standard method of American Public Health Association (APHA).

#### **2.4 Physical Parameters taken**

##### **pH**

Values of pH were measured by portable digital pH water analyses kit with pH electrodes. The instrument was calibrated with buffer solutions having pH values of 4 to 9. A pH of 7.0 indicates a neutral solution, pH values smaller than 7.0 indicate acidity, pH values larger than 7.0 indicate alkalinity.

- the sample was measured into a conical flask.
- the pH electrode was inserted into the sample
- the value of the pH was then read on the calibration on it.

**Specific conductance**

The value of Electrical Conductivity (EC) is a measure of the ability of ions in a solution to carry electric current. A measure of the ability of water to conduct an electrical current varies with temperature. Magnitude depends on concentration, kind, and degree of ionization of dissolved constituents. The EC values were measured by portable kit with electrodes. The meter was switched on and its probe dipped into the sample contained in a beaker. The electrical conductivity was read directly and recorded in micro-Siemens per centimeter.

**Temperature**

Thermometer was used to measure this. The thermometric bulb containing the mercury was vertically immersed in the effluent and allowed to stand for some minutes till the temperature reading was steady before taking reading.

**Turbidity**

The turbidity levels were measured in Nephelometric units. The turbid meter was first of all calibrated in order to make sure the instrument is capable of giving accurate results for analyzing the water samples. The water sample was shaken to mix thoroughly. After the disappearance of air bubbles, turbidity was determined by filling the water sample into a curvature and inserted into the Digital turbidometer compartment to allow light pass through it. The reading displayed was the turbidity value.

**Total Suspended Solids (TSS)**

- Filter paper of diameter 5.5cm was dried to a constant weight ( $w_1$ ) at  $103-105^{\circ}\text{C}$  in an oven.
  - cooled to room temperature in a desiccator and the weight was noted.
  - Gooch funnel and rubber adapter were fixed to a filtering flask,
  - the glass fiber was placed into the Gooch funnel carefully with the aid of a pair of tongs.
  - The water sample was thoroughly mixed on a magnetic stirrer, after which 50ml was quickly measured into the filtering apparatus.
  - After filtration elapsed, the filter paper containing the suspended particles was put into the oven for 1 hour at  $103\pm 2^{\circ}\text{C}$  to dry.
  - This was allowed to cool in a desiccator and reweighed  $w_2$ . The weight ( $w_2$ ) was taken.
  - The difference in the two weights  $w_2 - w_1$  was noted.
- Where  $w_1$  = Initial weight of filter,  $w_2$  = Final weight of filter

$$\text{TSS} = \frac{\text{Weight loss } (w_2 - w_1) \times 1000}{\text{Volume of sample}} \dots\dots\dots 2.1$$

The Equipment and materials used were:

Electronic hot plate (Gallenkamp, 125567AMP, England), Crucible, Whatman filter paper (No.4), Measuring cylinder (Pirex), Weighing balance (Ohaus – CP413).

**Total Dissolved Solids**

- The sample was stirred with a magnetic stirrer and a measured volume was taken onto a glass fiber.
- The glass beaker was earlier washed successively three times with distilled water, allowing complete drainage between washings.
- The beaker was dried to a constant weight.
- A known volume of the sample was measured in a volumetric cylinder and filtered into the weighed dried beaker (using previously dried filter).
- Total filtrate was weighed  $w_1$ . The beaker containing the suspended particles was put into the oven for 1 hour at  $103\pm 2^{\circ}\text{C}$  to dry.
- This is allowed to cool in a desiccator and weighed again to get  $w_2$ .

Where  $w_1$  = Initial weight of beaker  
 $w_2$  = Final weight of beaker

$$\text{TDS} = \frac{\text{Weight loss } (w_2 - w_1) \times 1000}{\text{Volume of sample}} \dots\dots\dots 2.2$$

The Equipment and materials used were:

Electronic hot plate (Gallenkamp, 125567AMP, England), Crucible, Whatman filter paper (No.4), Measuring cylinder (Pirex), Weighing balance (Ohaus – CP413).

#### Alkalinity by Titration

- 50ml burette was severally rinsed with 0.02 N HCL.
- The burette was filled with the HCL solution, making sure there were no air bubbles in the tip, and that the meniscus was readable at close to 0.00ml on the burette scale.
- 100 ml of the water sample to be analysed was measured into a 250 ml Erlenmeyer flask.
- This was titrated to a bromo cresol green (pH = 4.5) end point.

#### Calculations

$$\text{Alkalinity} = \frac{\text{titre} \times \text{normality of HCL} \times 50,000}{\text{Volume of sample used}} \dots\dots\dots 2.3$$

This is expressed in terms of milligrams of calcium carbonate per liter.

#### Equipment used-

Retort stand, Burette, Funnel, Beaker, pH meter (labtech 1167).

#### Reagents

- Hydrochloric acid (0.02 N)
- Bromo cresol green indicator
- Phosphate determination

- Exactly 100ml of the homogenized and filtered sample was pipetted into a conical flask.
- The same volume of distilled water (serving as control) was also pipetted into another conical flask.
- 1ml of 18M H<sub>2</sub>SO<sub>4</sub> and 0.89g of ammonium persulphate were added to both conical flasks and gently boiled for 1½hrs, keeping the volume to 25-50cm<sup>3</sup> with distilled water. It was then cooled.
- A drop of phenolphthalein indicator was added. This was neutralized to a faint pink colour with the 2M NaOH solution.
- The pink colour was discharged by drop-wise addition of 2M HCl.
- Distilled water was added to the solution to make up to 100ml.
- For the colorimetric analysis, 20ml of the sample was pipette into test tubes.
- 10ml of the combined reagent was added, shaken and left to stand for 10mins before reading the absorbance at 690nm on a spectrophotometer, using 20ml of distilled water plus 1ml of the reagent as reference.

#### Methods for Calibration

- Standard phosphate solution: 219.5 mg of dried AR potassium hydrogen phosphate was dissolved in distilled water and made up to 100ml, where 1ml = 50.mg. of phosphate.
- 10ml of the stock solution was made up to 1000ml to give 1 ml = 0.05 mg.
- Standards of strength ranging from 0 (blank) to 0.05mg/L at intervals of 0.01mg were prepared by diluting the stock with distilled water.

$$\text{Concentration of sample} = \frac{\text{Absorbance of sample} \times \text{Concentration of standard}}{\text{Absorbance of standard}} \dots\dots\dots 2.4$$

The Equipment and materials used were

UV Spectrophotometer (Apel PD-3000 UV), Beaker (pyrex), Measuring cylinder (pyrex), Pipette, Pipette pump (pyrex), Cuvette.

#### Reagents used-

SO<sub>4</sub> (18M), Ammonium persulphate (0.8g), Phenolphthalein indicator, HCl (2M), Distilled water

#### Chloride Determination

Chloride was analysed according to APHA standard method (APHA; 1998)

#### Procedure:

- A 100ml of the clear sample was measured through pipette into an Erlenmeyer flask
- the pH was adjusted to 7 – 10 with either H<sub>2</sub>SO<sub>4</sub> solution.
- Then 1ml of K<sub>2</sub>CrO<sub>4</sub> indicator solution was added
- it was titrated using standard solution of AgNO<sub>3</sub> which made it to turn to a permanent reddish brown colouration. End point is pinkish yellow.
- The titer volume was noted.
- The AgNO<sub>3</sub> titrant was standardized and a reagent blank established. A blank of 0.2-0.3ml is usual for the method.

Calculation: Chloride concentration = Titre value (x) 10 = mg/l

The Equipment and materials used were

Pipette (pyrex), Burette(pyrex), Retort stand, Beaker (pyrex), Funnel



Reagents:

Standard Silver nitrate  $\text{AgNO}_3$  (1 ml = 0.5 mg chloride)

Potassium chromate  $\text{K}_2\text{CrO}_4$  (5%) (Indicator)

Determination of Salinity

To determine the salinity, the result gotten from the determination of the chloride was multiplied by 0.0018066.

Salinity = chloride content x 0.0018066 (ppt)

Sulphate Determination

Method: Sulphate was analysed according to APHA standard method (APHA; 1998)

Procedure:

-250 $\text{m}^3$  of the sample was measured out and dried in a crucible.

-Three (3) drops of concentrated Hydrochloric acid was added into the dry crucible to moisten it.

-30 $\text{cm}^3$  of distilled water was added to this, and all the content were mixed together by stirring.

-The mixture was boiled and filtered into a beaker.

-The crucible was washed three times with 30 $\text{cm}^3$  of distilled water.

Digestion

-The filtrate was heated to boiling

-10 $\text{cm}^3$  of 10%  $\text{BaCl}_2$  solution was added to it, drop by drop with constant stirring for the development of turbid suspensions of barium sulphate.

-The mixture was digested for about 30 minutes, filtered and the filter paper was washed with warm distilled water.

-This was allowed to cool before filtering through a pre-weighed filter paper.

-The filter paper containing the precipitate was dried in an oven and was allowed to cool in desiccators.

-Thereafter, it was weighed. The difference in weight was noted.

-The sulphate concentration was calculated with the formula below;

Calculation

$\text{Mg/dm}^3\text{SO}_4 = \text{Mg BaSO}_4 \times 411.5\text{cm}^3$  of water sample.

**$\text{MgBaSO}_4^{2-}$  concentration** =  $\text{MgBaSO}_4^{2-} \times 411.5$  of calibrate the volume.

The Equipment and materials used were

Crucible, Electric hot plate, Measuring cylinder, Filter paper, Oven (Mammert 12880KL, Germany),

Desiccator, Weighing balance

Reagents: Concentrated HCl, 10% BaCl

Dissolved Oxygen Determination

-The water sample was put in a 250ml bottle,

-1ml of  $\text{MnSO}_4$  solution and 1ml alkali-iodide-azide reagent were added well below the surface of the liquid.

-It was stoppered with care to exclude air bubbles and mixed by inverting and rotating until clear supernatant water was formed. It was then allowed to settle for 2 minutes,

-After the settlement, 1ml of concentrated  $\text{H}_2\text{SO}_4$  was added by allowing the acid to run down the neck of the bottle,

-the stopper was replaced, and mixed by gentle inversion until dissolution of the precipitate was completed. At this stage, the iodine must have been uniformly distributed through the solution.

-2ml of the solution was titrated with 0.0125M  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  (sodium thiosulphate) solution to a pale straw color

-2ml of starch solution was added as indicator, which turns the color blue;

-the titration was preceded by adding the thiosulphate solution drop wise until the blue color disappears. The reappearance of blue color was disregarded.

$$\text{D.O} = \frac{\text{mole of titrant} \times \text{normality of titrant} \times 8000}{\text{ml of sample}} \dots\dots\dots 2.5$$

The Equipment and materials used were

Refrigerator (L.G, Model GL 2250M), Sample bottle, Measuring cylinder, Conical flask, Pipette pump, Stopper

**Reagents:**  $\text{MnSO}_4$ , sodium thiosulphate,  $\text{MnSO}_4$ , alkali-iodide-azide,  $\text{H}_2\text{SO}_4$ , starch solution

Determination of Biochemical Oxygen Demand

-The water sample was put in a 250ml bottle,

-1ml of  $\text{MnSO}_4$  solution and 1ml alkali-iodide-azide reagent were added well below the surface of the liquid.



- It was stoppered with care to exclude air bubbles and mixed by inverting and rotating until clear supernatant water was formed. It was then allowed to settle for 2 minutes,
- After the settlement, 1ml of concentrated H<sub>2</sub>SO<sub>4</sub> was added by allowing the acid to run down the neck of the bottle,
- the stopper was replaced, and mixed by gentle inversion until dissolution of the precipitate was completed. At this stage, the iodine must have been uniformly distributed through the solution.
- 2ml of the solution was titrated with 0.0125M Na<sub>2</sub> S<sub>2</sub>O<sub>3</sub> · 5H<sub>2</sub>O (sodium thiosulphate) solution to a pale straw color
- 2ml of starch solution was added as indicator, which turns the color blue;
- the titration was preceded by adding the thiosulphate solution drop wise until the blue color disappears. The reappearance of blue color was disregarded.
- Carry out the titration in duplicate

$$\text{D.O} = \frac{\text{mole of titrant} \times \text{normality of titrant} \times 8000}{\text{ml of sample}} \dots\dots\dots 2.6$$

The general equation for the determination of a BOD value is

$$\text{BOD (mg/l)} = D_1 - D_5 \dots\dots\dots 2.7$$

Where D<sub>1</sub> is the initial DO of the sample, D<sub>5</sub> is the final DO of the sample after 5 days.

The BOD was not diluted because the concentrations were not high.

The Equipment and materials used were

Refrigerator (L.G, Model GL 2250M), Sample bottle, Measuring cylinder, Conical flask, Pipette pump, Stopper

**Reagents:** MnSO<sub>4</sub>, sodium thiosulphate, MnSO<sub>4</sub>, alkali-iodide-azide, H<sub>2</sub>SO<sub>4</sub>, starch solution

Determination of Chemical Oxygen Demand

-1ml of the sample was measured into a 250 beaker.

-2.5ml of 5% K<sub>2</sub>CrO<sub>4</sub> digestion reagent was slowly added and mixed.

-3.5 ml of concentrated sulphuric acid reagent was added into the tube, making sure it reached the bottom.

-This was capped and the content mixed together.

-Then it was transferred into a water bath and heated at 50 degree.

-A blank test was also conducted.

-Distilled water was added to make up the volume to 50 ml.

-2 drops of phenolphthronlein indicator was added.

-It was then titrated with 0.05M of Ferrous ammonium sulphate solution (Morh salt).

$$\text{Calculation= COD as mg/l= } \frac{A - B \times 8000}{\text{ml of sample}} \dots\dots\dots 2.8$$

Where

A= Titre of blank, B= Titre of sample, M= Molarity of FAS (0.05m)

The Equipment and materials used were

Electric hot plate (Gallenkamp 125567 Amp, England), Water bath, Beaker, Burette, Measuring cylinder, Conical flask (pirex), Pipette, Pipette pump (pirex),

**Reagents:**

K<sub>2</sub>CrO<sub>4</sub> (5%), Ferrous ammonium sulphate (0.05M), Sulphuric acid (concentrated), Phenolphthronlein (indicator),

Determination of heavy metals

Heavy metal analysis was conducted using Atomic Absorption Spectrometer according to the method of APHA 1995 (American Public Health Association).

**Workingprinciple:**

Atomic Absorption Spectrometer's working principle is based on the sample being aspirated into the flame and atomized when the AAS light beam is directed through the flame into the monochromator and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristics absorption wavelength, a source lamp composed of that element is used making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Earlier before now, the metals were digested using concentrated nitric acid.

The Equipment and materials used were

Electric hot plate (Gallenkamp 125567 Amp, England), Whatman filter paper, Reagent bottle, Volumetric flask (pirex), Pipette, Pipette pump (pirex), Atomic Absorption Spectrometer, AAS (240 FS AA Agilant, USA)

**Reagents:**

Nitric acid (concentrated)

**III. Results and Discussion**

**3.1 Results**

**Table 3.1: Mean concentration of Ukwaka stream for the six months**

Parameters	Units	July	August	September	October	November	December	Mean
pH	-	6.18	6.18	6.37	7.02	7.77	7.41	6.82
Temp	<sup>0</sup> C	31.35	23.40	34.65	31.83	30.04	35.03	31.05
EC	μS/cm	116	127.13	150.13	208.25	220.50	227.63	174.94
TDS	mg/l	15.08	22.20	27.31	30.86	35.45	40.96	28.54
TSS	mg/l	5.76	9.08	6.21	2.53	3.69	3.00	5.05
TS	mg/l	20.84	30.18	29.52	28.39	32.14	38.96	30.01
Turbidity	ntu	26.06	45.98	488.81	270.73	416.81	272.55	253.49
COD	mg/l	201.96	280.36	307.35	289.00	333.73	326.19	289.77
BOD	mg/l	28	30.71	42.61	53.60	57.56	64.43	47.74
DO	mg/l	69.53	67.13	53.04	47.21	44.13	40.76	53.63
Alkalinity	mg/l	10.88	23.30	53.73	20.70	24.50	21.63	25.79
Phosphate	mg/l	3.09	3.14	7.32	6.56	9.36	10.16	6.61
Chloride	mg/l	43.06	84.94	138.44	170.92	172.13	213.75	137.21
Salinity	ppt	0.062	0.147	0.395	0.363	0.311	0.386	0.277
Sulphate	mg/l	219.92	200.93	211.26	221.48	221.16	236.29	218.51
Cadmium	ppm	0.015	0.090	0.042	0.021	0.140	0.165	0.078
Zinc	ppm	0.511	0.400	0.387	0.553	0.597	1.698	0.691
Copper	ppm	0.024	0.039	0.036	0.068	0.034	0.127	0.055
Iron	ppm	0.707	1.539	1.383	2.651	14.636	0.984	3.650
Lead	ppm	0.366	0.156	0.149	0.160	0.576	0.490	0.316

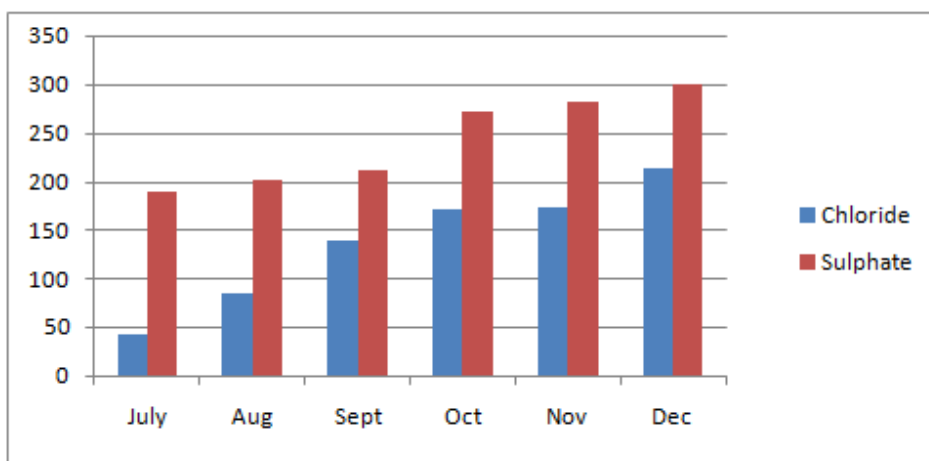
**Table 3.2 Comparison of Mean concentration on Ukwaka Stream, Effluent with standards**

Parameters	Units	Ukwaka	Effluent	WHO1993	FEPA	SON (Nigeria)
pH	-	6.82	6.30	6.5-8.5	6.5-8.5	6.50-8.5
Temp	<sup>0</sup> C	31.05	31.7			
EC	μS/cm	174.94	210.82	1000	100	100
TDS	mg/l	28.54	19.29		500	NA
TS	mg/l	30.01	30.81	500	NA	500
Turbidity	ntu	253.49	249.95	5.0	5.0	5.0
COD	mg/l	289.77	257.33	250	NA	NA
BOD	mg/l	47.74	17.60	NA	NA	NA
DO	mg/l	53.63	62.60	NA	NA	NA
Alkalinity	mg/l	25.79	26.52	100	NA	100
Phosphate	mg/l	6.61	5.243	NA	NA	NA
Chloride	mg/l	137.21	146.83	250	250	100
Sulphate	mg/l	218.51	167.48	500	250	100
Cadmium	ppm	0.078	0.022	0.003	0.01	0.003
Zinc	ppm	0.691	0.688	5.0	5	5.0
Copper	ppm	0.055	0.032	2.0	1.0	1.0
Iron	ppm	3.650	2.342	0.3	0.3	0.3
Lead	ppm	0.316	0.636	0.01	0.05	0.01

**3.2 Discussion**

It would be stated that the results of the analyses indicate that the discharge of industrial wastes and waste dump into the Ukwaka stream has contributed to the large scale pollution. Results showed that vegetable oil industry effluents is an acidic complex aqueous media composed of widely-distributed organic and inorganic materials dissolved as well as suspended in water. It affected the stream in such a way that the upstream and downstream water were polluted and unsuitable for human consumption and aquaculture purposes. The effluents released from the industries and the dumped solid wastes have a significant negative impact on the water quality, and the ecosystem because it affected the physical, chemical and biological characteristics of the stream ecosystem. The continued discharge of the effluents may result in severe accumulation of the contaminants. This can constitute dense growth of microbial population due to the changes in physical status and presence of anions and cations in the receiving water bodies which hampers the quality of water and also affects the aquatic life form; affect the lives of human as well as animals around this river. The present investigation indicates that Ukwaka stream is not safe. This study deduced that volume of effluent discharged into the Ukwaka stream was already overtaxing their capacity for self-purification. Hence, there is an urgent need to treat the effluents before the final discharge.

The samples were slightly acidic in wet seasons of July to September on almost all the sites but a bit alkaline from October to December. The levels of biological oxygen demand, electrical conductivity, and suspended solids were relatively high in dry season of October to December (**table 3.1**). The results also implicated site C (600m), to be the most polluted site, probably being the site close to the dumping site. Generally, the pollution level was found to be significantly high in dry season, October to December but relatively low in rainy season July to August. The observed variations in the level of pollution in each site could be traced to seasonal variations. Results of the study showed that the color of water was brownish to dark black and emitted noxious smell due to the industrial effluents and waste dump. The higher EC and TDS were found at the site C, which also indicates the greater amount of salts in the water due to the dumped solid waste. The four sampling sites showed a number of variations in the levels of sulphate, and chloride present in water. However higher values were observed from October to December. It established a corroboration of the submission of [23], [47] that these ions are washed into the stream during the rainy season and continue to accumulate to reach its peak during the dry season when farming activities along the river bank is usually reduced to the minimum.



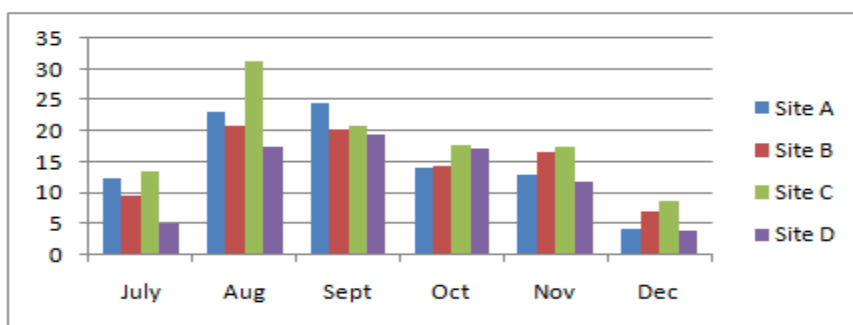
**fig. 3.1 Variations of Chloride and Sulphate**

The common practice of dumping of both agricultural and industrial wastes into water was also implicated [45] to increase level of nitrates, sulphate and some metals in surface waters leading to increase in plants and algal growth in the water which leads to depletion of oxygen. The observed variations in the level of pollution in each site could be traced to seasonal variations..

**Total Dissolved Solid**

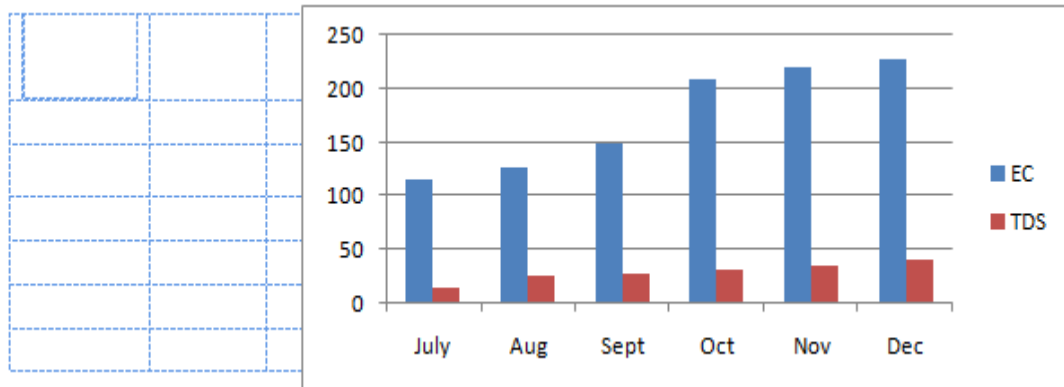
As indicated in **figures 3.2** the maximum total dissolved solids were observed in the months of August and September than in any other months. Higher level of TDS during the wet season is more likely due to the influence of runoff into the surface water. Waters with high total dissolved solids (TDS) are unpalatable and potentially unhealthy. In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles.

The higher EC and TDS were found at the site C, **Fig. 3.2**, which indicates the greater amount of salts in the water due to the dumped solid waste.



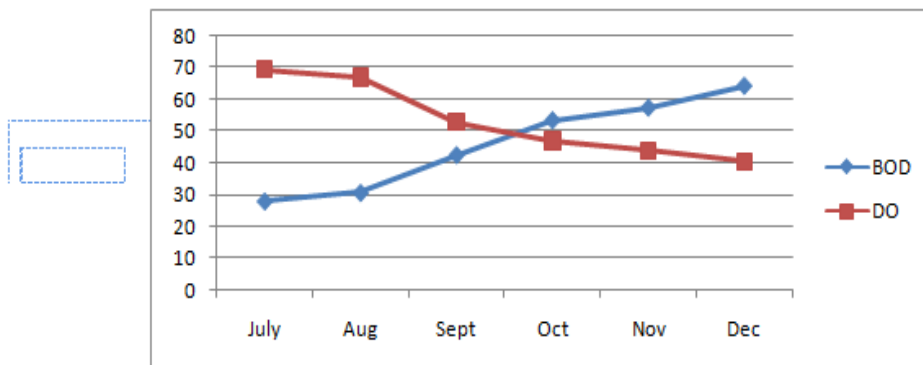
**fig 3.3 Concentration of TDS at various sites in the Months**

The degree of relationship between EC and TDS of the water samples depicted that the value of EC is increasing with the increasing of TDS value as shown in **table 3.1** and **Fig. 3.3** below.



**fig. 3.4 Variations of EC and TDS in the months**

The result of the study revealed that the value of BOD and DO have a significant negative relationship where the level of BOD is decreasing with the increasing of the DO contents and vice versa **fig 3.5**.



**Fig. 3.5 Negative variation between the BOD and DO**

#### IV. Conclusion

It would be stated that the results of the analyses indicate that the discharge of solid waste dump into the Ukwaka stream has contributed to the large scale pollution.. The organic contaminants leading to high BOD and COD values are possibly due to soluble and stable emulsified organic matter in the dumped wastes. The water quality was relatively unacceptable at the points of collection the stream, both the physical and chemical qualities of the water at all the sites became impaired, an inference that suggested a significant pollution from the wastes dump. The prevailing practice of unregulated and uncontrolled discharge of waste dump into water bodies constitutes serious abuse and portends serious danger to their species diversity. The study revealed that both the upstream and downstream water were polluted and unsuitable for human consumption and aquaculture purposes. By current water quality standards, the water of the stream is not fit for human consumption and it can be regarded as polluted stream in terms of water quality parameters.

The continued dumping of solid wastes may result in severe accumulation of the contaminants. This can constitute dense growth of microbial population due to the changes in physical status and presence of anions and cations in the receiving water bodies which hampers the quality of water and also affects the aquatic life form; affect the lives of human as well as animals around this river. The volume of solid wastes discharged into the Ukwaka stream was already overtaxing their capacity for self-purification; hence there is an urgent need to stop discharging of the wastes to save the stream water from further deterioration.



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