EFFECT OF LIQUID INDUSTRIAL EFFLUENT ON THE QUALITY OF WATER FOR AGRICULTURAL PRODUCTION.(A CASE STUDY OF KADUNA REFINERY AND PETROCHEMICAL COMPANY)

By

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DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communication, published and unpublished work were duly referenced in the text.

……………………………………… 22/02/2010

Shehu Ahmed Hamza Date

CERTIFICATION

This project entitled "Effect of Liquid Industrial Effluent on the Quality of Water for Agricultural Production" by Hamza Shehu Ahmed, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to Allah (S.W.A), my Auntie, Hajiya Risikat Muda Shittu and to the Entire family of Alhaji Abdulrahim Hamzat.

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ABSTRACT

The effects of liquid industrial effluent on the Quality of surface water as it affect farmers downstream" Kaduna Refinery and Petrochemical Companies was studied to determine the nature of the effluent discharged into Romi River by the refinery and to compare it with set standard by FEPA and WHO. To achieve this, samples were collected from the refinery retention pond, the Romi River upstream and downstream. The physico-chemical properties of the samples were analyzed using special equipments. The result of the analysis revealed following results; a slightly alkaline pH of 8.59 for the refinery retention pond ,a high BOD value for the retention pond, upstream and downstream of 84.19,106.20 and 97.68 respectively are far above standard of 10.0 by FEPA effluent quality standard. The value of heavy metals though low are also higher than set standards. It was however established from the result that the effluent discharged by KRPC has some deleterious effect on the aquatic habitat and humans if consumed directly. As well it's not suitable for agricultural purpose. Its however recommended that effluent be retreated to meet set standards before been disposed in the river.

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CHAPTER ONE

INTRODUCTION

1.1.Background to the Study

The importance of water in the control of disease had long been recognized (WHO, 2000).Water is a factor of production in virtually all enterprise, including agriculture, industry and the service sector (UNESCO, 2006). The importance of safe drinking water is the birthright of all humankind as clean air (TWAS, 2002). It is also reported that the majority of the world's population especially in most part of Africa and Asia does not have access to safe drinking water and that as much as much as 6million children dies daily as result of water borne diseases linked to scarcity of safe drinking water and sanitation (TWAS, 2002). WHO (2004) pointed out that diseases related to contamination of drinking water constitute a major burden on human health and that intervention provide a quality drinking water and provide significant benefit to health.

For most communities, the most secure source of safe drinking water is pipe-borne water from municipal water treatment plants. Often most of water treatment facilities do not deliver or fail to meet the water requirement of the served community; due to corruption, lack of maintenance or increased population. The scarcity of piped water has made communities to find alternative source of water; ground water sources and surface water been a ready source. Wells and streams water are a common ground water source readily explored to meet the community water requirement or make up the short fall.

However, treatment of wastewater, especially that of an industry like Kaduna Refinery and Petrochemical Company is quite important to alleviate the environment from it's high degree of pollution. The Kaduna Refinery is located in the southern part Kaduna state Nigeria generates large quantities of effluents daily. These effluents are discharged into natural water body after treatment. Though the compositions of the effluents are regulated by various laws, it is not known whether they comply with the legally accepted toxicant levels of refineries and petrochemicals plants in Nigeria. Furthermore, the impact of these toxicants on the quality of the effluent receiving water body has not been investigated. The present stud investigates quality of Kaduna refinery and Petrochemicals Company and is aimed at determining the toxicity levels of the effluents produced from the company by determining the concentrations of levels of the different contaminants.

The treatment procedure of the effluents in the company is as below;

Equalization
↓
Sedimentation
↓
Flocculation
↓
Floatation dissolved air basin
↓
Biodegradation

The company is composed of two plants; Refinery Section and Petrochemical section. The products obtained from these two paints are numerous with different boiling points. These products include; Domestic Kerosene, motor spirit, Jet aviation oil, thermal fluids, boiler feed oil, gear oil, cooking gas, thermal fluid etc.(NNPC, 2001)An industry like this which engages in the above mentioned activities will definitely require a lot of water for cooling equipments and other services thereby getting the water polluted both physically and chemically.

1.2.Sources of oil industry wastewater(KRPC)

1.2.1. **Cooling water**: - an important part of the refinery operation is the complex heat recovery system from process unit. For this, water is a coolant.

1.2.2. **Process oily water:** - from the lube, fuel plant, this wastewater is generated.

1.2.3. **Oily Drains:** - From crude oil tanks, intermediate tanks to oily sewer etc.

1.2.4. **Chemical Wastage:** - Alkaline and acidic water, drainage and flushing from equipments using chemical reagent and samples, water from the laboratories etc.

1.2.5. **Oil Free Water:-** Drain from boiler, Rain water from roof and terraces not contaminated with oil, surface drainages etc.

1.2.6. **Sanitary Waste Water:-** From septic tanks, water from administrative block buildings, medical centre and central rooms

1.3. Statement of Problem

Wastewater from Kaduna Refinery and Petrochemical company processes is discharged directly into the Romi River. The wastewater is though first sent to the water treatment plant of the company where it undergoes appropriate physical, chemical and biological treatment before discharge into the retention pond where it flows directly into Romi River. However, the people living along the bank of the River complaint of foul smelling well water and since they have no other source of water for domestic activities, it is important to treat carefully the wastewater before discharge into the River and it should be ensured that minimum standard of effluent concentration is achieved before discharged into the river.

1.4. Objective of the Study

The objectives of this study are;

i) Determine the components of the wastewater effluent discharge into the adjacent Romi River by the Refinery.

ii) Compare the discharge effluent with set standard by the regulatory authorities to determine whether the environment is been changed by the operation of the Refinery.

iii) Identify and assess those components of the effluents that pose environmental hazards.

1.5. **Justification of the Study**

The various settlements along the course of Romi River from the point of discharge of the wastewater have compound of foul smelling water fetched from wells nearby. In addition the people who complement their livelihoods by fetching from the small tributaries that take their source from the River complained of gradually reducing stocks of fish as compared to the past. Farmers also complained of poor yield of irrigated crops as compared to the paste. The negative development may be attributed to the presence of pollutants discharged in the river by the processes of the refinery. To be fair, the refinery has it's elaborate and highly sophisticated wastewater treatment plant, but the study seeks to find answers to the following questions; is the treatment plant performing its work? If yes, to what extent.

1.6. **Scope of the Study**

In order to achieve the aim of this study, samples of the discharged effluents will be collected at the upstream, downstream and point of discharge and at the downstream and the following parameters will be measured; pH, temperature, total hardness, turbidity, titrable alkalinity, oil content, total suspended solid (TSS), total dissolved solid (TDS), conductivity, biological oxygen demand (BOD), chemical oxygen demand (COD). The samples will be collected over a three week period and the test will be carried out in a suitable laboratory.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Environmental Pollution

The systematic pollution of our environment is one of the biggest hazard that humanity faces today, though we live in an age where technological achievement has influenced the living standards of individuals, nations and societies, yet these achievement sometimes exact a high price from our national resources, our environment can be defined to mean the whole complex of physical, social, cultural, economic and aesthetic factors which affect individuals & community and ultimately determine their form, character, relationship & survival. Examples of such factors are air and water quality erosion control, noise pollution etc. (John *et al.*, 2000) Therefore environmental pollution is the direct or indirect alteration of the physical, thermal, biological, aesthetic or radioactive properties of any part of the environment in such a way that as this safety or welfare of any living species. However pollution may occur naturally but the terms is more commonly applied to changes brought by the emission of individual pollutants or by the careless discharge or disposal of human domestic sewages. It also include the production of excessive noise by aircraft factories and release of excessive heat (Mcheal, 2004).

Technology has been and still is man's major investment for harnessing the resources of his environment for his benefit. But there is no any technological achievement without some accompanying deleterious effect of the environment and every solution appears to generate a new problem (Micheal, 2001). When in 1988, the United Nation Environmental Program (UNEP) released the result of its studies on the ain't it because clear of threatening pollution. The highlight of the report on air, water and food quality amount were that an estimated 12 button of the world's city population breathed heavily polluted air, that 10% of the worlds river were heavily polluted and that chemical contamination of good had reached unacceptable dangerous levels. The global picture from the 10-15yrs studies in 60 countries conducted by UNEP's Global Environmental Monitoring System is that the air in many Urban areas particularly those of the developing Nations like India, Brazil and Nigeria is heavily laden with sulphur dioxide, suspended particulate matter, (dusts and smoke) Carbon monoxide, and lead and many others. Also in the world's water are disease-causing substances of all kinds from industries, feacal coliform, and nitrates from organic fertilizers. Food contamination identified include lead in canned foods, mercury and polychlorinated biphenyl in fish, persistent pesticide like DDT and Aldrins in many crops and naturally occurring toxins (Aflatoxins) from fungal infections in nuts and cereals (SARDC, 2005).

Environmental pollution is generally classified into three viz; air, water and land pollution, for the purpose of this study, we consider water pollution

2.1.1. **Water Pollution**

Pollution of water bodies is often caused by discharge of domestic and industrial waste into aquatic ecosystem, some of the discharged pollutants may have indirect effect while its substances usually not considered as pollutants may become so under special circumstances. Water pollutant emanating from industrial and domestic sources includes; oxygen demanding wastes disease causing agents, synthetic organic compounds (detergents, pesticides) inorganic chemicals and minerals, sediments, plant nutrients (phosphorus and nitrates), radioactive substances, thermal discharge and oil. Normally wastewater is conducted to treatment plants for removing or reducing the concentration of pollutants interfering with the self cleaning process (mechanism of water bodies which is made possible by different microorganism). But often, either a pollutant does not degrade naturally or the shear volume of the pollutant discharged is sufficient to overwhelm the self claming process of the microbial population.

Pollution of the water affects the lives of a grd. Many people throughout the world especially those living in industrialized areas. Water population results as harm to humans, and to plant and animal life, unpleasant odour, reduced water clarity, damage to property, and a reduction in recreational quality of coastal inland water and beaches. Certain types of pollution may even render some areas unfit for normal habitation and therefore constitute a serious obstacle to socio-economic development. The rivers and lakes near urban centers emit disgusting odours and fish are killed in millions along sea coast, moreover the meal of aquatic animals are terminated and unsafe to eat because of excessive levels of pollutants like mercury and pesticides in their tissues. Drinking water sources are often threatened by increasing concentration of pathogenic organisms and new toxic chemicals disposed by industry and agriculture, for example, nearly 75 – 80% of Indian population is exposed to unsafe drinking water. (Rao, 2006).

History is repeated with cases of water pollution. In 1988 an accidental discharge of water containing high ammonia level into the Okrika River from National Fertilizer Company of Nigeria. In one near PortHacourt caused massive fish kills and socio-economic problems for the surrounding villages. 1st November, 1986 a fire incident occurred in Sandoz chemical company, large amount of toxic chemicals, insecticides and herbicides were washed into the Rhine River by water use in quenching the fire. Massive fish kills involving thousands tones of fish occurs over several kilometers along the River and across many countries (WHO, 2004)

2.2. Characterization, Sources and Effects of Industrial Effluent

Broadly, industrial effluent depending on the source and constituent can be clarified under the following; physical, chemical, radiological, ethnological, bacteriological, biological and virological characteristics. There effects on man, plants and animal life differs greatly and is dependent upon the relative concentration of threshold limit and the adaptability and resistance of the affected environment or organisms. For the purpose of this study, the clarification will be linked to physical and chemical (metallic and non-metallic and organic constituents) characteristics.

2.2.1. **Characteristics of Refinery Wastewater Effluents**

Generally the wastewater effluents are divided into three main groups;

(i) Physical characteristics are odours, electrical conductivity, suspended matter

(ii) Chemical characteristics and

(iii) Biological characteristics

2.2.2. **Water Quality Parameters**

2.2.2.1. **pH**

Knowledge of the pH of water is essential since it determines the acidity or alkalinity and it plays an important role in the choice of technique to be used in treatment. The pH value of a solution is defined as the negative logarithm of the solutions hydrogen ion concentration. $pH = \log [H^+]$.

The pH measurement is an important consideration in determining the corrosive action of water. Proper pH measurement and control can increase productivity and ensure consistent quality in numerous industrial and laboratory processes (Owen, 2007).

2.2.2.2. **Conductivity**

This is the measure of the ability of water to conduct electricity. It is the reciprocal of resistance. It is determined by estimation of dissolved salts in natural and treated waters.

2.2.2.3. **Turbidity**

This is caused by the presence of suspended solids in the water that restricts their clarity. It is described as the reduction of the transparency of a sample because of the presence of particulate waste matter. Only a very small number of natural water bodies are absolutely free of suspended matter. Industrial and domestic wastewater that wash into receiving streams and excessive flooding condition contributes to turbidity (Owen, 2007).

2.2.2.4. **Alkalinity "P" and "M"**

Alkalinity in wastewater results from the presence of hydroxides, carbonate and bicarbonates of reactive metals like calcium and magnesium. The soil wastewater are normally alkaline and they receive their alkalinity from the waste supplied from the ground and materials added during domestic and industrial use. Alkalinity is determined by titrating against standard acid additions necessary to titrate to the phenolphthalein ($pH = 8.3$) methyl orange and points ($pH = 4.3$) are called "P" and "M" – alkalinity respectively.

2.2.2.5. **Dissolved oxygen (DO). Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)**

The dissolved oxygen content of water results from the photosynthesis and respiratory activities of the biota in the open water and the diffusion gradient at the air-water inter-phase and distribution by wind-driven mixing (Owen T.L, 2007).

The amount of oxygen in water utilized by the micro organism or aquatics is the biological oxygen demand. While the amount of oxygen used to oxidize the oxidable chemicals in water is termed chemical oxygen demand.

2.2.2.6. **Oil Content**

This is the amount of grease or oil spills that is present in water. The presence of oil the surface of water helps to raise its temperature and also reduces the light penetration into the water. Thereby altering photosynthetic activities of aquatic plants (Gwendolyn H., *et al* 2000)

2.2.2.7. **Lead**

It occurs as galena (Pb S). it occur in the oxidation number as +2 and +4. it is more stable in the oxidation number +2. lead is easily hydrolyzed in water. Lead is used in engineering to make cables, sheeting, coils of coolers and water pipes. Soluble compounds of lead are more absorbed and are readily poisonous (Liptrot, 2003).

The U.S. department of Health and Human Services shows that the blood Lead levels below those that produce clinical symptoms is demonstrated effect on intentional performance suggest that lead may be associated antisocial behaviour. (Needleman, 2003) Lead exposure result in Kidney damage.

2.2.2.8.**Iron**

Heamatite Fe_3 O_3 is used as an abrasive and a few iron compounds are administered as drugs (McLeans, *et al*) and important functions of iron containing materials is the transport of oxygen, 80% is in the hemoglobin and remaining in the iron containing enzymes. Iron is also required in the formation of red blood cells in which deficiency of iron results in anemia. It helps in development of fetus and avoid anemia in pregnant and lactating women (Debrun, 2000).

The disadvantage of iron is that it procures objectable taste and colour in drinks at higher concentration and it stains clothes and plumbing fixture (Chunlett, 2001)

2.2.2.9.**Ammonia**

Ammonia (NH_3) is usually present in low (less than 1mg/L) quantities in non-polluted well-oxygenated water, but may reach 5 to 10mg/L in the anaerobic hypolimnious of a entropic lake. High concentration of ammonia when present as the undissociated NH_4OH is toxic. The relative proportion of the toxic NH_4OH increases with pH (Owen, 2007).

2.2.2.10. **Chromium**

Its main ore is chromites Fe.Cr_2O_4 (FeO.Cr_2O_3) it is resistant to corrosive attack. It reaction to organic substance may be explosive.

Chromium acid formed within Cr (IV) oxide dissolves in water, though poisonous is used for cleaning laboratory glass wares. It is used in the production of alloy steels, which are very hard for the manufacture of ball bearings. It is used also as an oxidant.

Chromium plays major role in glucose metabolism. The main effects resulting from the intoxication of the substances are dermatitis (skin disease) kidney damage, and it is also a potential carcinogenic (Chunlett, 2001)

2.2.2.11. **Cadmium**

Cadmium is white and lustrous but it is a ternishable metal.It is soft, malleable and ductile with oxidation number +2. hydrated sulphate ($CuSO_4$ (8/3) H_2O) is used the construction of western cell, (a device whose electromotive force is constant and accurately known). Rounded only minute current are drawn from it.

It is used in batteries in the form of nickel cadmium. Industrially the metal is used for plating and cadmium sulphide is used as orange pigment. It is non-essential element, which accumulates in liver and kidney's having deleterious effect on bone structure and kidney (Chunlett, 2001).

2.3. **Volume of Samples**

This depends on the analytical method but enough should be collected for repeated analyses if needed, further more, two points are noteworthy: when contact of the sample with aim is to be avoided, the sample container should be completely filled; when samples requires vigorous shaking before taking position for analysis, the sample container should not be completely filled.

2.4. Sample Collection

For many application concerned with natural water. It is sufficient simply to immerse a container (e.g. a bucket) in the water of interest so that it fills with water which may then be poured into appropriate sampling containers, alternatively, the sample containers may sometimes be directly immersed in the water. Many authors recommend that sample containers be rinsed two or three times with sample before finally filling the container. The type of container suitable for particular analysis is determined and is given in the available analytical method.

2.5. Sample Transportation and Storage

Generally, the shorter the time that elapses between collection of a sample and its analysis, the more reliable will be the analytical results, therefore, if possible, samples should be rapidly transported and analyzed as soon as possible. Preservation procedures should be such that they do not interfere with the method of analysis.

Finally, sample containers must be clearly and unambiguously identified so that subsequent analytical results can be properly interpreted. Generally the label on the sample should have the following data; Name of water body, location of the sampling position, date and time of collection, temperature of the water, appearance of the water body and sample.

2.6. Pollution Control

Pollution control does not mean the total elimination of all substances put into the air, water, or on the land because even in the proper and natural use of water and air and land impurities are added though only in amounts that permits renewal of purity. Most of the pollution problems in real situation are interrelated and integrated and hence a system of approach to a vital control is needed. Garbage, rubbish, industrial and agricultural solid waste pollutes the land but municipalities and industries that burn their waste also contribute to air pollution. Pollutants in the air or land are leached or washed by rain hence contributing to water pollution similarly substances in water settle out in sediments and end up as pollution of the land.

2.6.1. **Water Pollution Control**

The major causes of water pollution are industrial, domestic, and agricultural waste. Therefore any pollution control most either eliminate or minimize pollutant emanating from these sources more so water pollution control depend on the principal desirable uses of water which include water supply (municipal and industrial), recreational (swimming, boating), fishes and ecological balance. The control of the polluting effects of industrial effluent is normally achieved by wastewater treatment to remove the contaminants so that the treated water can meet acceptable quality standards. Wastewater treatment processes can be broadly classified into physical, chemical or biological and these processes are applied in prevailing situation of influent concentration, composition and condition and specification of the effluent. Also water pollution caused by agricultural sources can be checkmated by improvement (improved biodegradability and decreased toxicity) in agricultural fertilizers and fungicides used in modern farming systems. In addition to discovering the use of recalcitrant chemicals like methyl-mercury and DDT. Furthermore, the treatment of domestic wastewater discharge into surface water has and can keep pollution in check.

2.7. **Impact Analysis**

Although industrialization is inevitable, various devastating ecological and human disasters which have continuously occurred over the last three decades or so implicates industries as the major contributors to environmental degradation and pollution problems of various magnitude (FEPA, 2002). It has become increasingly apparent that the environmental impact of any new technology must be carefully evaluated before it is applied and even the impact of old technology still in existence is being re-evaluated. The identification and evaluation of the environmental consequences of a proposed development and the measures intended to minimize adverse effects, otherwise known as Environmental Impact Assessment (EIA) was introduced first in the USA; however it is now a standard practice in all countries including Nigeria.

As earlier stated the environmental impact of already existing industries is equally important and is achieved through environmental impact audit which is and independent assessment of the current status of an industry compliance with acceptable environmental requirements. The evaluation of an industry's current environmental compliance, policies, practice and control is very important because of the failure of most industrial establishment to maintain and uphold the measures initially put in place to minimize adverse environmental effects as contained in the environmental impact statement, a written report based on detailed studies carried out in the course of an EIA.

Generally, an environmental impact (any alteration of environmental conditions or creation of a new set of environmental conditions, adverse or beneficial course or induced by the action or set of action under consideration (can be categorized as either primary or secondary). One way to describe the distinction is that project 'impact' generally cause primary impact and project output cause secondary impact-which is more significant than the former. In the biophysical environment, the secondary impacts can be especially important for example removal of vegetation may cause excessive sediment in the receiving stream. This is turn will reduce the amount of sunlight that can penetrate the water, thus reducing the dissolved oxygen in the water. As a result, the aquatic life and water quality of the stream will be adversely affected (Coje, 2004).

The measure of the water pollution impact-which this project is concerned about is given by the percentage change in water quality of the river as a result of the project which is formulated thus;

$$\frac{A-B}{B}\times 100$$

Where A = water quality in area before project

B = water quality after project

This measure could be computed for each of the basic water quality component, namely dissolved oxygen, lead, phenol, etc, however the above formulation can be modified to suit the intended purpose of this project thus;

$$\frac{(\text{water quality upstream})-(\text{water qaulity down stream})}{\text{water qaulity upstream}}\times 100$$

In general, the types of environmental impact and their assessment (qualitative and quantitative) include population growth, high density urbanization, industrial expansion, resource exploitation, air, water and noise pollution, undesirable land use patterns, damage to life systems, threat to health, and other consequences adverse to environmental goals. Nigeria effort in pollution control is evident by the establishment of the Federal Environmental Protection Agency (FEPA) by Decree 58 of 1988, which is charged with the statutory responsibility to protect, restore and preserve the ecosystems of the Nigerian environment. And the areas of environmental pollution control includes; effluent limitation, water quality for industrial uses, industrial emission limitation, noise exposure limitation, management of solid and hazardous waste and pollution abatement in industries.

Economic development can be compatible with environmental conservation. Hence the present problems of environmental resources degradation need not arise within the frame work of sustainable development. To this effect the FEPA in its 1991 Guideline and Standards for Environmental Pollution Control in Nigeria stipulated that "the public or private sector of the economy shall not undertake or embark on authorize projects or activities without prior consideration at an early stage, of their environmental effect" where the extent, nature or location of a proposed project or activity is such that is likely to significantly affect the environment, it EIA shall be undertaken. It further stated that EIA shall include at least the following;

(a) A description of the proposed activities

(b) A description of the potential affected environment includes specific information necessary to identify and assess the environmental effects of the proposed activities.

(c) An assessment of the likely or potential environmental impact of the proposed activity and the alternatives including the direct or indirect, cumulative, short term and long term effects.

(d) An identification and description of measures available to mitigate adverse environmental impact of the proposed activity and assessment of these measure etc. (Abdullah, 2007)

CHAPTER THREE

3.0. METERIALS AND METHOD

3.1. Description of Study Area

Kaduna Refinery and Petrochemical Company limited (KRPCL) lies between latitudes 4° 321 and 5° 321 North, and longitude 7°251 and 8°251 East. It is located in Sabo area of Kaduna State of Nigeria. It was established by the Federal Government of Nigeria in 1983. The feedstock used in the company is delivered to it in liquid form via pipeline. The major products of the company are petroleum products such as kerosene, engine oil, Aviation fuel, gear oil and etc.

FG3.11 MAP OF KADUNA STATE SHOWING THE LOCAL GOVERNMENTS

3.2. Sampling Points

Three sampling points were chosen based on the purpose of then study and the other factors mentioned in chapter 2

Sampling Point 1: About 1km upstream the receiving river (Romi River).

Sampling Point 2: The refinery retention pond after treatment

Sampling Point 3: About 3km downstream the receiving river (Romi River)

Sampling were carried out at these points so that the environment impact of the effluent will be determined by comparing the upstream and downstream concentration of some parameters with both the local and international standard to find out how much change has occurred as a result of the discharged effluent.

3.3. Analysis

Analysis were performed to determine some physical and chemical characteristics of the sample. The presence and concentration of the following parameters were determined: phenols, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, lead (Pb^{2+}), cadmium (Cd^{+}), Chromium (Cr^{2+}), Sulphate (SO_4^{2+}), Sulphide (S^{2-}), Chloride (Cl^{-}), total suspended solid, turbidity, electrical conductivity and temperature. All analyses were done within 24 hours without the use of preservatives, except for the storage at $4^{O}C$. The method of analysis were based on the 2005 Association of Official American Chemist (AOAC) Standard. Because of limited space only eight analytical procedures are given.

3.4. Materials

3.4.1. **Atomic Absorption Spectrometer (AAS):** The atomic absorption spectrophotometer. (AAS) is an analytical instrument used for the determination of trace elements (such as heavy metal) concentration in part per million or parts per billion (ppm or ppb). The atomic absorption method offers the analyst considerable advantages of speed, case of handling provision and general freedom from interference.

It ahs therefore rapidly established itself as a highly sensitive and specific method. It may b e used to determine more than sixty elements in a wide variety of samples (AOAC, 2005).

3.4.2. **Infrared Spectrometer (IR):** Almost any compound having covalent bonds, whether organic or inorganic will be found to absorb various frequencies of electromagnetic spectrum. The infrared spectroscopy find it's widest applicability in the analysis of organic materials (Compound)

IR spectroscopy is also useful for quantitative analysis, although it is considerable difficult to achieve accurate and precise result with IR spectroscope (AOAC, 2005).

3.4.3. **Ultra-Violet Spectrophotometer:** Most organic molecules and functional groups are transparent in the portions of the electromagnetic spectrum which are called the ultra-violet (vv) and visible (VIS) region. Ultra-violet spectroscopy has a long side continuing history of use in analytical chemistry. The technique is based on measuring the absorption of near – UV or visible radiation by molecules. Radiation in this wave length region causes electronic transitions at structure of the molecule(AOAC, 2005)

3.4.4. **pH Meter:** It is a digital device with an electrode which when inserted in sample gives the degree of acidity or alkalinity of it. It also displays the temperature of the sample.

3.5. Methods

There are three samples collected from different sources. The points where samples are collected are; Refinery Retention pond; Romi River up-stream and Romi River downstream which are 1 km and 3 km from the source point respectively.

3.5.1 Parameters Analysis

3.5.1.1 pH And Temperature: Apparatus – pH Meter

Procedure:

pH meter and associated electrode were standardized against reference buffer solution of pH 6 to 8.5 (buffer 7) and the temperature of water was compensated for. The electrodes were then rinsed with distilled water and carefully dried using tissue paper. The sample was then poured in a 100ml beaker, which was stirred using a magnetic stirrer. The electrodes were placed in the sample. The galvanometer reading was recorded and the temperature of the sample was also displayed and recorded.

3.5.1.2 Turbidity: Apparatus – Turbidmeter

Procedure:

The sample cell was rinsed and filled with distilled water, which ws later placed in the turbidimeter meter. The turbidmeter was calibrated using the CH, span and zero button so that the meter gives a zero deflection which is the turbidity of distilled water. The sample cell that contains the distilled water was removed and refilled with the sample and placed back in the turbidity meter. The meter reading is recorded as the turbidity of the sample.

3.5.1.3 Conductivity: Apparatus – Conductivity meter

Procedure:

The conductivity was washed with distilled water and then rinsed several times with the sample. The sample was taken into small beaker and stirred for far using magnetic stirrer. The conductivity cell electrode was inserted into the sample. The meter deflection was taken and recorded. The value of the meter reading was multiplied by the number indicated on the bottom pressed and the cell constant.

Calculation: Conductivity (μs/cm) = (meter deflection) x (bottom constant) x (Cell constant).

3.5.1.4 Total Suspended Solids: Apparatus – Hot Plate, two 50ml beakers, oven, filter paper, analytical balance, evaporating dishes.

Procedure:

Two 50ml beakers were washed with distilled water and dried in the oven. They are then cooled in an autoclave and weighed. The beaker were tagged RET (Refinery Effluent Total Solid) and RED (Refinery Effluent Dissolved Solid). The beakers were weighed and their masses noted. 40ml of the sample was filtered into the beaker tagged 'RET' and the beaker plus the sample were weighed and the mass noted. 40ml of the sample (unfiltered) was poured into the other beaker tagged "(RED)" and the mass of the beaker and sample is noted. The two beakers were then placed on a hot plate to allow for evaporation. T he beakers were placed in an autoclave to cool after which they are reweighed and their masses noted.

Calculation: $Total\ Solid = \frac{Weight \text{ of dried sample (RET)} \times 10^6}{\text{Weight of wet sampmle}}$

Where,

Weight of dried sample (RET) = final weight of RET beaker and filtered sample – initial weight of RET beaker.

Weight of wet sample = Weight of beaker and sample – weight of empty RET beaker

$$\text{Dissolved Solid} = \frac{Weight \text{ of dried sample (RED)} \times 10^6}{\text{Weight of wet sampmle}}$$

Where;

Weight of dried sample RED = Final weight of beaker and unfiltered sample – Initial weigh of RED beaker

Weight of wet sample = Weight of beaker and sample – weight of empty RED beaker

Suspended Solid (SS) = Total Solid – Dissolved Solid

3.5.1.5 **Biological Oxygen Demand:**

Apparatus: Law temperature incubator for BOD, empty stock solution bottle, Air pump, 2 corked incubator bottles, magnetic stirrer, retort stand with magnetic metal surface, burette, pipette, measuring cylinder, and beakers.

Reagents: Distilled water, starch indicator, 0.037moldm^{-3} sodium thiosulphate solution ($Na_2S_2O_4$), sodium azide (Na2N), 0.0188 moldm^{-3} magnesium sulphate, dilute tetra oxosulphate (VI) acid 21.75g dipostassium phosphate (K_2PO_4), 8.5g potassium phosphate (KH_2PO_4), 33.4g disodum phosphate (Na_2HPO_4) $7H_2O$, 1.7g ammonium chloride (NH_4Cl). All were dissolved in distilled water and made up to 1 litre. 0.2moldm^{-3} magnesium sulphate ($MgSO_4$), 0.025moldm^{-3} anhydrous calcium chloride ($CaCl_2$), 0.001moldm^{-3} hexahydrate Ferric Chloride ($FeCl_3.6H_2O$).

Procedure:

One (1) litre of distilled water was measured using a measuring cylinder and then transferred into an empty solution bottle. This water was aerated mechanically using air pump for one hour. 1m each of dipotassium phosphate, 0.2moldm^{-3} anhydrous calcium chloride, and 0.001moldm^{-3} hexahydrate ferric chloride were added to the aerated distilled water in the sequence mentioned above. The mixture was thoroughly shaker after which the two corked incubator bottles were partially with 2ml each of the effluent sample into it. One of the bottles was placed in the incubator which was set at 20^{O}C to allow for 5days incubation.

The content of the other incubator bottle was then transferred into a beaker and 2ml each of 0.188moldm^{-3} $MgSO_4$ and (Na_3N) Sodium azide were added. The mixture was allowed to settle for ten minutes. The beaker was then placed on the magnetic surface of the retort stand, the magnetic stirrer was placed inside. 2ml of H_2SO_4 (diluted) was added to the mixture and stirred for about two (2) minutes.

A colour change from light brown to orange was noticed. 2ml of starch solution was then added to the already stirring solution. This caused a colour change from orange to black. The burette was filled with the 0.037moldm-3 $Na_2S_2O_4$ solution. Titration was carried out by carefully adding the $Na_2S_2O_4$ into the stirring mixture until the mixture become colourless (indicating an end point). The titre value was taken and recorded as the dissolved oxygen (DO) of the first day.

On the fifth day, the incubated sample was brought out and transferred into a beaker. The same procedure was carried out on the mixture and the titre value also taken and recorded as the dissolved oxygen on the fifth day.

$$\text{Dissolved Oxygen (DO)} = 0.2 \times \mathit{titre\ value} \times 1000$$

Bottle Volume

Where 0.2 = 0.2mg of oxygen equivalent to 1ml of $Na_2S_2O_4$

100 = Constant

$$\text{BOD} = \frac{(\text{first day DO}) - (\text{fifth day DO}) \times \text{Average bottle volume}}{\text{Sample Volume}}$$

3.5.1.6 **Chemical Oxygen Demand (COD):**

Apparatus: 5 conical flask, 2 heating mantles, burette, pipette filter, analytical weighing balance, spatula, foil paper, refluxing flask, pipe horse, round cooling bath, measuring cylinder, glass beads (anti-bubbles), magnetic stirrer, retort stand with metal surface incubator.

Reagents: Ammonium ferrous sulphate $FeSO_4(NH_4)_2SO_4.6H_2O$ solution, distilled water, concentrated H_2SO_4, silver nitrate salt ($AgNO_3$) 0.042moldm^{-3} potassium dichromate solution, ice, mercury(II) sulphate (H_2SO_4).

Procedure:

Two empty conical flasks were labeled "blank" and "RE" (Refinery Effluent). 50ml of distilled water was measured and transferred into the flask labeled "Blank" 5ml of effluent was measured and transferred into the flask labeled "RE" and 45ml of distilled water was added to the RE flask. The flasks were placed in the round cooling bath containing ice block. 1g of $AgNO^3$ and 70ml of concentrated H_2SO_4 were added into the mixtures. This mixture (Orange clouration) was shaken carefully to ensure proper mixing and uniformity. Some glass beads were added to the mixtures to prevent bubbling while refluxing. Refluxing was carried out for 2 hours. A standard was prepared by preparing a mixture of 25ml of 0.042moldm-3 K_2Cr2O_7 and 20ml of concentrated H_2SO_4 in conical flask and made up to 250ml mark by adding distilled water. The glass was tagged "Std" (Standard) and placed in incubator to cool. The refluxing contents of the "RE" and "Blank" flasks were transferred into 2 other conical flask tagged "RE" and blank respectively. They are now made up to 250ml mark with distilled water. The standard is also retrieved from the incubator and the three flasks were stirred using magnetic stirrer while they are placed in the magnetic metal surface.

The burette was filled with liquid ammonium ferrous sulphate and clamped to the retort stand. The mixture that is "Std" "RE" and "Blank" were titrated in turn against ammonium ferrous sulphate $FeSO_4(NH_4)_2SO_4.6H_2O$ solution until the colours are changed from orange to reddish brown, indicating the end points. Their respective titre value were recorded.

Calculation

Chemical Oxygen Demand (COD) = (A x B x 8000)

Sample Volume

Where

$$A = \frac{(\text{Volume of } K_2Cr_2O_7 \text{ used for "Std"} \times \text{Molority of } K_2Cr_2O_7)}{\text{Titre Value for "Std"}}$$

B = "Blank" titre value – "RE" titre value

8000onstant

3.5.1.7 Oil Content:

Apparatus: Measuring cylinder, foil paper, analytical balance, magnetic stirrer, separating funnel, filter paper two 50ml volumetric flasks, infrared spectrophotometer, beaker, pH meter.

Reagent: Dilute tetra oxosulphate (VI) acid, sodium chloride, carbon tetrachloride (stock solution) and silica gel.

Procedure: 200ml of effluent was measured and poured into beaker. The pH was taken and adjusted to pH of 5 (using the dilute H_2SO_4). 33g of NaCl was weighed and poured into the effluent. It was then stirred until NaCl dissolved. 30ml of CCL_4 was added and the mixture shaken vigorously and was allowed to stand for separation. Some silica gel was poured into a filter paper that was placed funnel which was on a 50ml volumetric flask to allow fast filtration. The organic layer was filtered out from the separating funnel into the funnel in the volumetric flask.

The filtrate was made up to 50ml mark using CCL_4 stock solution. The volumetric flask was tagged "RE". A blank was prepared using about 50ml of filtered CCL_4 with silica gel into a volumetric flask tagged "blank". The filtrate was scanned against blank using an infrared spectrophotometer.

3.5.1.8 Alkalinity "P" (Due to phenolphthalein):

Apparatus: Beaker conical flask, burrette.

Reagent: Phenolpthalein indicator, 0.02moldm^{-3} hydrogen chloride

Procedure: 2 drops of phenolphthalein indicator was added to 5ml of the sample in a conical flask. The appearance of a pink colour indicated the presence of alkalinity "P". The mixture was then titrated against 0.02moldm-3 HCL until solution become colourless. The alkalinity was then calculated;

$$Alkalinity\text{"}P\text{"} = \frac{A \times M \times 1000}{\text{Volume of Sample}}$$

Where A – Volume of titrated standard HCL

M – Morality of titrant 0.02 moldm^{-3} HCL

3.5.1.9 Alkalinity "M" (Due to Methyl Orange):

Apparatus: Same as "P" above

Reagent: Methyl orange indicator, 0.02moldm-3 HCL

Procedure: Add to the same 5ml of ample in alkalinity "P", 2 drops of methyl orange indicator. The appearance of yellow colour indicated the presence of alkalinity "M". This was titrated against 0.02moldm^{-3}HCL acid until the solution turns pink. Alkalinity is thus calculated;

$$Alkalinity\text{"}M\text{"} = \frac{A \times M \times 1000}{\text{Volume of Sample}}$$

3.5.1.10 Ammonia:

Apparatus: pH meter, filter paper, Nesslertube, conical flask

Reagents: ZnSO4, sodium hydroxide solution (NaOH), sodium-potassium tertrate solution, Nessler solution:

Procedure: 1ml of ZnSO4 solution was added to the sample because it was turbid. NaOH solution was added gently and mixed until the pH was about 10.5. it was filtered after it has settled. The filtrate containing 0.1mg of ammonia nitrogen was diluted to 50ml in a Nesslertube. Two(2) drops of sodium-potassium tertrate solution was added to prevent cloudy tube was and was mixed. 1 ml of Nessler solution was added.

The colour developed after 10minutes was compared with the standard. A compensatory blank was used and the concentration determined from a previously prepared calibration curve.

Calculation: Concentration in ppm of the ammonia nitrogen was calculated in the original sample as follows.

Ammonia Nitrogen mg/L = (A x 100)/s

Where A = mg of Ammonia Nitrogen observed

S = Volume of sample

Calculation of Ammonia Nitrogen in mg/L of ammonia in the original sample is as follows

Ammonia (mg/L) = E x 1.22

Where E = ppm of Ammonia Nitrogen

3.5.1.11 Phosphate Content:

Apparatus: Measuring cylinder, beaker, double UV spectrometer, wash bottle, pipette filter

Reagents: Ammonium molybdate for phosphate $(NH_4)_6MO_7O_{24}.4H_2O$, distilled water

Procedure: 50ml of the effluent was measured and transferred into a beaker tagged "RE". 25ml of $(NH_4)_6MO_7O_{24}.4H_2O$ was added to the effluent.

There was a change of colour to light yellow. A blank was prepared by pipetting 25ml of Ammonium molybdate into another, beaker tagged "blank"

The reading was taken using a double beam UV spectrophotometer.

Calculation:

Phosphate content = $A \times 50.17$

Where A = Absorbency reading

50.17= Constant

3.5.1.12 Phenol Content:

Apparatus: Measuring cylinder, pH meter, three beakers, conical flask, double beam UV spectrophotometer, distillation box and pipette filter

Reagents: Dilute tetraoxophosphate (V) acid (H_3PO_4) solution, 0.4moldm^{-3} hydrated copper tetraoxosulphate (VI) acid ($CUSO_4$) distilled water, 0.37moldm-3 Ammonium Chloride solution, Ammonia stock solution, 0.098moldm^{-3} 4-ammonia antipyrine ($C_{11}H_{14}N_2O$) solution, 0.24moldm-3 $K_3Fe(CN_6)$ potassium Ferric Cyanide solution.

Procedure: 100ml of the effluent transferred into a beaker, the pH was adjusted to the 4 using dilute H_3PO_4 solution. 5ml of 0.4 moldm-3 of $CuSO_4.5H_2O$ Solution was added to the effluent in the beaker. Distillate of 100ml was obtained from the two mixtures. The distillate was tagged "blank" 5ml of 0.037 moldm^{-3} NH_4Cl solution was added to the sample beaker tagged "RE" and the Blank.

The pH of the content of the two beakers were adjusted within the range of 8.95 – 9.8, using the ammonia stock solution. 2ml of 0.098moldm^{-3} ($C_{11}H_{13}N_3O$) solution and 2ml of 0.24moldm^{-3} $K_3Fe(CN)_6$ solution were added to the blank and RE. The mixtures were allowed to stand for about 15minutes for colour development.

A purple colour was obtained and then the absorbance was taken in the double beam spectrophotometer at a wavelength of 510μm.

Calculations:

Phenol Content = A x 10.29

Where A = Absorbent reading obtained

10.29= Constant value

3.5.1.13 Heavy Metal Concentration:

Apparatus: Atomic absorption spectrophotometer (AAS), 100ml volumetric flask, 1ml and 10ml pipettes, wash bottle, beakers.

Reagents: 100ppm lead salt standard solution, 100ppm iron salt solution, 100ppm chromium salt solution, distilled deionized water.

Procedure: Serial dilution of 1ppm, 2ppm, 3ppm and 5ppm of the various salt solutions were prepared in the 100ml volumetric flaks. The flasks were tagged according to the different concentration to be prepared. Depending on the concentration of the specific metal salt required, the corresponding millimeter (ml) was measured and poured into the corresponding tagged volumetric flask. For example, to the one (1) ppm volumetric flask, 1ml of the metal salt solution was made up to the 100ml mark to give 1ppm of the salt.

The same procedure was carried out for all other concentration, 2ppm (2ml was used), 3ppm (3ml was used and so on. The serial dilutions were used to standardize the AAS for the corresponding metal analysis.

The AAS was set at a particular wavelength for the specific metal to be analyzed before standardizing. The values displayed on the screen for the dilutions were taken and used to plot a graph.

The slope of the graph was taken and inverted. The inverse of the slope was taken as a constant value. This constant was used to multiply the value of the sample metal absorbency obtained. The result was from the sample metal absorbency. The result was taken as the metal concentration of the sample.

CHAPTER FOUR

4.0. RESULTS AND DISCUSSION

4.1. **RESULTS:** Analysis of samples as compared with FEPA effluent Quality standard and WHO Drinking Water Quality Standard (2004).

Table 4.1.

S/No.	Parameters	Refinery Effluent	Upstream Romi River	Downstream Romi River	FEPA effluent Standard	WHO Standard
1	PH	8.59	6.54	6.55	6.5-9.2	6.5-8.5
2.	Temperature (^oC)	30.94	25.66	26.66	30.00	Ambient
3	Turbidity (NTU)	56.68	30.68	30.50	Ns	5
4.	Conductivity (μS/cm)	338.3	617.07	530.20	NS	100
5	Total suspended Solid (Mg/L)	218.85	71.30	121.44	30.00	NS
6.	Total Dissolved Solid (Mg/L)	112.07	67.84	32.98	500	1000
7.	Alkalinity (PPM)					
	–Methy Orange	11.78	9.83	0.00	10.00	NS
	-Phenolpthalein	13.23	16.23	15.42	10.00	NS
8.	BODS (Mg/L)	84.19	106.20	97.68	10.00	NS
9.	COD (Mg/L)	438.23	195.90	241.86	40.00	NS
10.	Oil Content	150.43	195.90	241.86	40.00	NS
11.	Ammonia NHs (Mg/L)	10.34	1.74	2.53	0.210	NS
12.	Phenol (Mg/L)	0.19	0.11	0.35	0.5	0.001
13.	Phosphate (Mg/L)	6.02	3.47	6.17	5.00	NS
14.	Iron (Mg/L)	0.313	0.00	0.00	0.3	0.3
15.	Lead (Mg/L)	0.20	0.007	0.03	0.05	0.05
16.	Chromium (Mg/L)	0.014	0.00	0.01	<0.01	0.05
17.	Cadmium	0.034	0.007	0.213	<0.1	0.005
18.	Zinc	0.217	0.067	0.30	3.0	5.0

- Ns - Not Stated
- < - Not detectable

4.2 DISCUSSION OF RESULT

The slightly alkaline nature of the effluent (pH, 8.59) can be attributed to the use of large amount of basic chemicals in the production process and water and wastewater treatment. However, it does not pose a threat to the receiving river because there is no significant change of pH between the upstream and downstream. As also observed, the upstream and downstream pH falls within the FEPA and the WHO drinking water quality standard (DWQS), so it may be postulated that the alkaline effluent has a neutralizing effect on the naturally acidic river (as shown by the upstream value of 6.34).

The effluent temperature (see Table 4.1) averages 30.94OC slightly above the 30^{O}C FEPA limit. A temperature decrease of 4.25^{O}C (30.94^{O}C to 26.66^{O}C) in the receiving river does not constitute a threat to aquatic plants and animals. According to A. James (John *et al.*, 2000), the suggested standard for heated discharge are less than 8^{O}C temperature rise in streams at any time, less than 6^{O}C temperature increase in summer for coarse fish and les than 2^{O}C increase in summer for salmonid fish, a delicate and temperature-sensitive specie.

As mentioned earlier, turbidity is as a result of the presence of suspended solids or particles in a body of water. The effects of these particles on aquatic life depends primarily on weather they remain in suspension and to a lesser extent on whether they are organic or inorganic. The effluent concentration of 56.68 Mg/L is higher than the permissible standard, the upstream value is just slightly below the downstream value. The effluent concentration of suspended solids is high and therefore constitute harm to the receiving river because "for concentration of suspended solids of less than 100 Mg/L, there is no evidence of any damage to the aquatic environment unless the solids are readily degradable organic environment unless the solids are readily degradable organic and cause other problems through deoxygenation" . The main problem in assessing the effects of the discharge of solids into water bodies is in predicting their hydraulic behavior, as stream conditions can change from deposition to erosion with changing river flow. Nevertheless, the concentration of suspended solids and the organic load (BOD) of 84.17mg/L is high compared with the National effluent standard value of 10.00 Mg/L.

Conductivity of the upstream is higher due to accumulation of the dissociable salt in the stations while it reduces as the river flow downstream (530.20 Ns/cm). It shows that there are some ionized impurities in the wastewater.

Oil content is high concentration in the petrochemical effluent (150.43) due to the following reasons; untreated water overflowing into retention pond during heavy downfall, equipment failure and leakage from storage tank. It is however higher in the Downstream (241.86) due to spillages. The presence of oil in water reduces the dissolved oxygen because there will be no air-water interface preventing oxygen from dissolving on the surface..This water may not be useful for irrigation. It cannot be utilized for fire service because oil will help in rekindling the fire.

Alkalinity P & M are less important in water quality parameters since it is determined by the kinds of compounds present that can collectively shift the pH to the alkalinity side or the acidity.

The value for biochemical oxygen demand (BOD 84.17 Mg/L) at the Refinery Effluent is very high in fact, well above the National effluent standard value of 10.00Mg/L. Moreover, despite the high Upstream value of (106.20 Mg/L), the downstream value is low. It is obvious that the suspended solid concentration has a direct bearing on the BOD. Therefore, it is glaring that the effluent contains a significant amount of biologically or biochemically degradable matter and, hence, exert an oxygen demand on the receiving river. While the BOD value gives an indication of only biologically oxidizable organic material degradable within a period of 5 days, that of the Chemical Oxygen Demand (COD) gives the total oxygen demand – biodegradable and non biodegradable organic matter. As seen from (Table 4.1), the COD value for the Refinery Effluent is(438.23 Mg/L), the upstream having a value of (195.90 Mg/L), and the downstream having a value of 2451.86 Mg/L when compared with FEPA Effluent Standard of (40.00 Mg/L) is observed to be very high with a difference of close to (400 Mg/L). This high COD will eventually exert an oxygen demand on the receiving river, and hence, has a deleterious impact on the aquatic life of the downstream section of the Romi River. The possible reason for high COD downstream was as a result of inflow of other wastewater from Southern Kaduna State small scale industries and the wash down of fertilizer from the farm in the river bank. Result shows that the water can be harmful to both aquatic and human life if consumed directly. Yield of crops irrigated with the water could also reduce significantly.

Ammonia and phosphate were present and in a high concentration due to additives used in the refining processes and there are also impurities in the rude petroleum oil, which have to be removed totally. The concentration did not conform to FEPA standard of 0.210 and 5.0 respectively. If there is an increase in pH, the toxicity of ammonia increases (Owen, 2007). They are also an oxidable chemical which increase COD when present in water.

The phenolic compound concentration (0.19 mg/L) in the effluent is below theFEPA's standard, but there is significant change in the downstream concentration (from 0.19 to 0.35 Mg/L) resulting from the discharged effluent. Furthermore, the downstream concentration far exceeds the WHO DWQS of 0.001 mg/L phenol in the effluent results mainly from the use of large amounts of organic compounds such as hydroxyl benzene, carbolic acid etc, while that in the upstream could be credited to natural tannins and lignin from plants and trees. Nevertheless, only when chlorination of phenol containing water (which may produce chlorophenols that have extremely bad tastes) is involved, that the concentration of phenols becomes a cause for concern. Therefore the effluent phenolic concentration is low enough not to cause the expected environmental impact – off flavour in fish tissue and aquatic foods.

Iron and zinc having values of (0.00 and 0.03) respectively at the downstream are also part of the impurities present in the crude oil, are expelled as waste from the crude petroleum oils to prevent wares and knocks in the motor engine. The concentration of the above metals in the wastewater is below FEPA Standard of (0.03 and 5.0). This water when consumed may not cause kidney damage, dermatitis. But the trace amount of zinc may accumulate in plants

Lead is toxic to aquatic organism, but its effects are less pronounced than those of cadmium and mercury. The degree of toxicity varies greatly and depends on water quality characteristics as well as the species being considered (FEPA, 2001; Michael, 2004). Though there is significant change (from 0.007 to 0.030mg/L) between the Upstream and Downstream concentration of lead, the effluent and downstream concentrations are below the FEPA standard (0.05mg/L) and the WHO DWQS (0.05mg/L). lead is usually particle-bound and does not affect or inhibit the production of phytoplankton (Michael, 2004).

Generally, the chromium concentration in the Upstream, Refinery Effluent and Downstream are (0.00, 0.014, and 0.10 mg/L) respectively which are above the FEPA and WHO Drinking Water Quality Standard. Many plant species are adversely affected by chromium concentration of (<0.01 Mg/L).

The cadmium concentration in the effluent (0.034mg/L) though below the FEPA standard, results in a significant increase in the cadmium concentration of the receiving river from Upstream value of (0.007 Mg/L) to downstream value of (0.013 mg/L). Fish and certain invertebrates have been found to be very sensitive to very low levels of cadmium in water and concentrations of around (0.01 mg/L) can retard the growth of aquatic plants. The World Health Organization recommends that drinking water contains less than 0.005 mg/L of cadmum. Concentrations greater than this cause disease of the kidneys and reproductive organs in humans and also affect fish (Miocheal, 2004). Therefore, it is obvious, with reference to the cadmium concentration in the effluent and the downstream section, that the discharged effluent from the KRPCL has some deleterious effects on the receiving river.

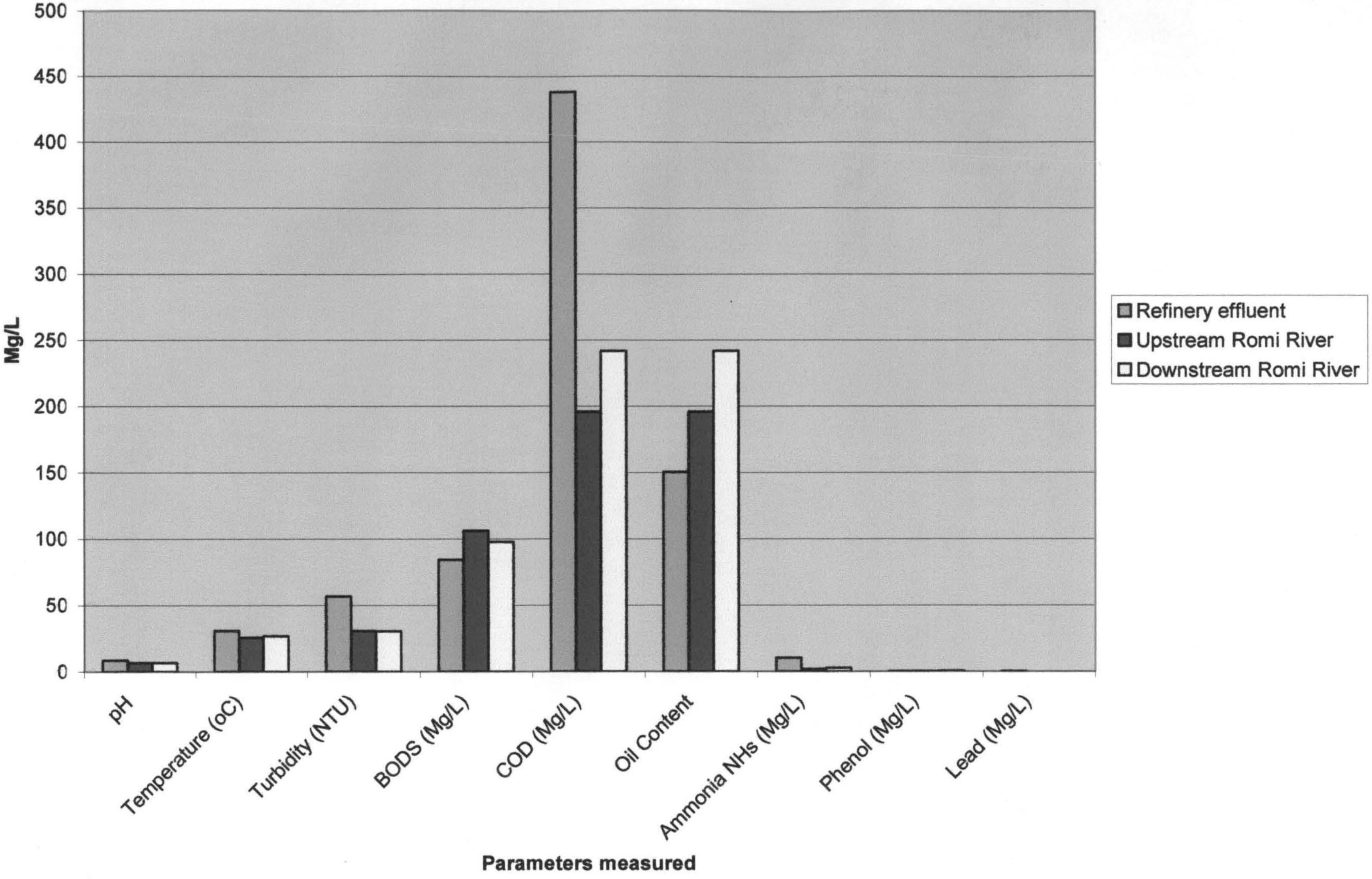

Figure 4.1: A Combine Bar chart of some important parameters measured

CHAPTER FIVE

5.0. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Even when the effluent from an industry complies with the FEPA effluent quality standard, declaring the receiving water body "safe" usually depends on the purpose for which it is to be used. The receiving Romi River is used for domestic and agricultural purposes.

Based on the result of the analysis and the discussion of results, the following conclusions were arrived at:

(a) That the pH and temperature of the effluent have no any environmental impact on the receiving river

(b) That the concentrations (in mg/L) of lead, BOD, chromium, oil and grease, phosphate, phenol and suspended solids are all above the FEPA effluent quality standard and so have deleterious effects on the receiving river.

(c) That the COD value for the effluent and the downstream exceed the FEPA limit and, hence, the effluent can be said to constitute a threat to the receiving river because a demand will eventually be exerted on the available dissolved oxygen during the chemical breakdown or oxidation of the non-biodegradable mater. This is evident from the generally low value of dissolved oxygen in the effluent and the downstream.

(d) That the concentration of cadmium in the effluent and the downstream is below FEPA limit, but when assessed based on the domestic use of the river in addition to the fact that cadmium can combine synergistically with *other* metals like copper and zinc, resulting in increased toxicity, the effluent can be said to have some likely deleterious impact on the receiving river and its users.

5.2. **Recommendation**

The control of water pollution is essential if water resources are to be properly managed and damage to wild life, recreation, crops, and human population is to be avoided. The processing units responsible for the presence of non-biodegradable organic matter and hence high COD in the effluent of the waste water treatment plant and eventually in the effluent are the dilution stream blow-down unit, the polypropylene and polyethylene plant, utilities plant and the laboratories.

Therefore, stringent monitoring measures should be put in place or modification (in raw materials or process) carried to reduce the amount of non-biodegradable organic substances generated from these units. Also the WWT plant should Endeavour to reduce the COD concentration in the effluent, even below FEPA standards, so that there will be minimal or no change in the downstream COD value.

Taking in to consideration that the surrounding communities use the downstream section of the river for recreational and domestic purposes, the KRPC management should strive to treat effluent to WHO drinking water quality standard. Generally, the management should ensure continuous and prompt maintenance of all processing units and continuous monitoring of the influent and effluent, and deviations should immediately be corrected. Furthermore, any subsequent work on a project of this nature should take the following factors into consideration: the period of sampling should be in the dry season and the frequency and duration of the sampling programme should be reduced to say, weekly, for a period of one month or fortnightly, for a duration of two or three moths. In addition to the parameters analyzed in this project, other parameters like ammonia, cyanide, copper, magnesium, calcium, mercury, zinc and faecal coliform should be analyzed for.

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APPENDIX

FEDERAL LIMITATION GUIDELINES IN NIGERIA PETROCHEMICAL INDUSTRIES

		Effluent (mg/L)	
WasteWater…	High volume waste matter, Storm water, Cooling water	Temperature (^{o}C)	30
		pH	6.5-8.5
		Phenol	0.5
		Ammonia (NH4+)	0.2
		Sulphides as H2S	0.2
		Total suspended Solids	30
		BOD5	10
		COD	40
		Lead as Pb2+	0.05
		Chromium (vi)	<0.1
		Cadmium as Cd2+	<0.1
		Emission (ug/m2)	
Gaseous. Emission..	Particulate ..	particulate	500
	Carbon black dust	Hydrocarbon	
	Sox	Volatile organic Carbon	
	NOx	(VOC)	600
	CO	Benzene	1500
	Hydrocarbons (HC)	Xylene	2300
	Benzene	toluene	2000
Valid Wastes	xylene		
	Oily chemical sludges		
	Off spec products		
	(Carbon black polypropylene Chunks)		
	Spent catalyst		
	Discarded packaging material		

INTERIM EFFLUENT LIMITATION GUIDELINES IN NIGERIA FOR ALL CATEGORIES OF INDUSTRIES

PAPAMETERS	Units in mg/L Limit for discharge Into surface water	Limits for land application
Temperature	Less than 40 C within 15 meters of outfall	Less than 40 C
Colour (Lovibonds)	7	-
pH	6-9	6-9
BOD5 at 20 C	50	500
Total suspended solids	30	-

Total dissolved solids	2000	2000
Chloride (as Cl)	600	600
Sulphate (as S042)	500	1000
Sulphide (as S2)	0.2	-
Cyanide (as CN)	0.1	-
Detergents (linear alkylate Sulphonate)	15	15
Oil and grease	10	30
Nitrate (as NO3)	20	-
Phosphate (as P043-)	5	10
Arsenic (as As)	0.1	-
Barium (as Ba)	5	5
Tin (as Sn)	10	10
Tran (as Fe)	20	
Manganese (as Mn)	5	
Phenolic compounds	0.2	
Chromium	<1	
Copper	<1	
Lead	<1	
Mercury	0.05	
Nickel	<1	
Selenium	<1	
Silver	0.1	
Zinc	<1	
Total metals	3	
Calciu (as Ca2+)	200	
Boron (as B)	5	
Chlorine (fee)	1.0	
Cadmium (Cd)	<1	