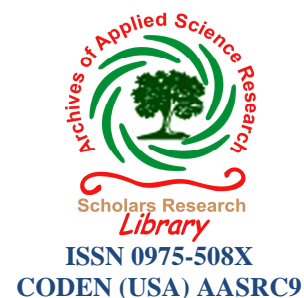




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Effect of Industrial Effluent on the Surrounding Environment

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ABSTRACT

Industrial activities contribute a lot of toxic wastes to the environment in general, hence this study was carried out to investigate the effect of industrial effluent on the neighbouring surrounding. Nickel, Copper, Cadmium, Zinc, Iron, Lead, Manganese, Cobalt and Chromium in the industrial effluents collected at two different points from a vegetable oil processing industry was investigated via AAS analysis. The pollution level of a vegetable oil processing industrial effluent was analyzed and compared with national and international standard for maximum permissible effluent quality limit. The untreated effluent was analysed by considering its physico-chemical parameters in the effluent sample using standard methods by American Public Health Association (APHA). It was observed that the values for pH, oil and grease, lead, Cadmium and iron exceeded the permissible limit of FEPA now Federal Ministry of Environment, Nigeria.

Keywords: Industrial effluent, Physico-chemical parameters, Heavy metals, Effect.

INTRODUCTION

Nigeria at the moment has established industries like petroleum refinery, soaps and detergents, food and beverages, breweries, textiles and apparels, building materials, timber products, wood and leather works, metal works, chemicals and plastics, clay and other industries [1,2]. All these industries produce various effluents that are discharged into the environment. Most large cities in Nigeria e.g. Lagos, Port Harcourt, Ibadan, Kano, etc, are feeling the pinch of pollution from industrial effluents [3]. It is needless to talk of tons of effluents disposed indiscriminately into the lagoon, rivers and streams. It has been realized that discharges of untreated or incompletely treated wastes containing algal nutrients, non-biodegradable organics, heavy metals and other toxicants will hasten the deterioration of receiving water bodies. There has been growing awareness of the need for effective treatment of various effluents before discharging into any public water body.

On a global scale, environmental pollution by food or related industries via effluent discharge has become a threat to plants and animals and may ultimately threaten the quality of human

life. In 1956, cases of minimata disease were reported in Japan [4]. The disease affects the brain, causing insanity and leading to death, as a result of pollution of water by industrial effluents containing methyl-mercury. Also, the Itai-Itai disease caused by cadmium poisoning originated in a prefecture factory in Japan. This disease damages the joints, softens the bones and causes the body to shrink and the affected person dies painful death [5]. One time or the other, there were cases of outbreak of mercury poisoning in Iraq and Nigeria when a number of people ate bread made from wheat which had been treated with alkyl-mercury as a fungicide [3,6].

Methods of wastewater treatment are grouped under two broad headings viz : Conventional and Physico-chemical method. The conventional methods are biological in approach. Bacteria are employed to break down the complex organic wastes into simpler ones so as to bring about purification. While these bacteria may bring about some purification in domestic wastewater, their existence is threatened by various toxicants contained in trade and food industrial effluents. This means that the conventional methods have limited application [6].

The demand for water of high quality calls for further investigation into alternative methods of treatment, which is dynamic in approach and complete in practice such that the various waste products of our modern technology can be adequately treated for safe discharge into the environment. Physico-chemical method of treatment does this efficiently. The method yields effluents of low suspended solids (SS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), etc, such that the effluents can be directly discharge into public water causes without fear of any impairment or can be re-used directly for industrial purposes such as cooling , quenching or washing [7,8,9].

Treatment of all kinds of wastewater prior to discharge into the environment is desirable so as to avoid pollution. Large quantities of untreated solid and liquid wastes are discharge indiscriminately into streams and rivers, particularly those flowing through towns, cities and villages [10, 11]. In this way, water is heavily polluted and water, which should be a blessing to life, becomes a carrier of poisons, toxicants and pathogens leading to dreadful diseases that cause death. Many diseases and premature deaths can be prevented by adequate care of our environment. Therefore, this study was carried out to ascertain the pollution load or processing industry and to compare the concentrations of each pollutant with national and international wastewater or effluent standards and emission guidelines.

MATERIALS AND METHODS

Introduction

There is a rapid increase in the pollution of our environment due to an increase in industrialization and developmental processes and other factors of pollution in the world today. If this increase is allowed , the problem of pollution of the environment will become more acute as the amount of pollutants being introduced to the environment continues to be on the increase. In other to keep this environmental risk in check, some safety measure must be applied. However, from the variety of analytical methods available, no standard method of analysis has been selected for particular types of environmental samples (soil, plant, water, air, and sediments). The analytical procedures applied to a particular pollutant depend on the facilities and the experience existing in the laboratory.

Sample collection or Sampling

Effluents were collected from outlets of a vegetable oil processing industry in Owo, Ondo State. The important parameters considered in this study include pH, temperature, hardness, alkalinity,

acidity, total solids, total dissolved solids, total suspended solids, dissolved oxygen, chloride, oil and grease, sulphate and heavy metals.

Effluent samples were collected from two different points. One liter sample was collected and mixed to form a composite from each point within and outside the premises of the industry. Polyethylene bottles were used for the sample collection.

The containers used were carefully washed with 1% HNO₃ acid and rinsed with tap water and distilled water. It was drained before the samples were collected after rinsing with the wastewater sample. The samples were labeled appropriately and transported to the laboratory where it was refrigerated at 4°C prior to analysis.

Reagents and Materials

Some of the reagents used are sodium thiosulphate, manganese (ii) sulphate, alkali-azide reagent, anhydrous calcium carbonate, calcium chloride, sodium sulphate, potassium dichromate etc.

Materials used includes: thermometer, pH meter, measuring cylinder, weighing balance, desiccators, separatory funnel etc.

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).

Quality Assurance Protocol

All reagents used were of analytical grade. Contaminations were checked by running blanks of all determination. All glass distilled water was used. All glass apparatus used were first soaked in hot soap solution, later in H₂SO₄/ HNO₃ acid (1:1) mixture, and then rinsed with copious amount of hot water followed by several portions of distilled water. All plastic containers were equally given the same treatment.

Preparation of H₂SO₄ / HNO₃ acid (1:1)

100ml concentrated H₂SO₄ acid and 100ml concentrated HNO₃ acids were gently added together in a conical flask to give (1:1) solution. The mixture was cooled under the tap while swirling.

Sample Treatment and Analysis:

Nitric Acid Digestion for Metals Prior to AAS Analysis

Procedure

50ml wastewater sample was measured into a beaker, followed by the addition of 3ml concentrated HNO₃ acid. The mixture was boiled and evaporated on a steam bath to the lowest volume possible (<5ml) before precipitation occurs. The mixture was allowed to cool, and then heated further with additional 5ml concentrated HNO₃ acid and then in excess until digestion was completed as shown by a light colored clear solution. The sample was evaporated to less than 5ml and allowed to cool. 10ml (1:1) HCL acid and 15ml distilled water was added to the cooled sample and heated for additional 15 minutes to dissolve any precipitates or residue. The walls of the beaker was washed with distilled water and then filtered. The filtrate was transferred to a 100ml volumetric flask and diluted to mark with distilled water. Portions of the solution were taken for required metal determination by ALPHA-4-AAS MODEL.

Physical Parameters**Temperature**

Temperature is the degree of hotness or coldness of a substance. The apparatus used for the measurement was mercury thermometer. 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 obtaining reading.

Total Solids (TS)**Procedure**

A clean dish of suitable size was dried at 103-105⁰C in an oven until a constant weight was obtained. It was subsequently cooled to room temperature in a dessicator and later weighed. 100ml sample was measured into a dish and evaporated to dryness on a steam bath. The outside of the dish was wiped and the residue was dried in an oven for 1 hour at 103-105⁰C. The dish was quickly transferred to a dessicator, cooled to room temperature and weighed. The dish was dried further in an oven for 10-20 minutes, reweighed after cooling to room temperature. This was repeated until the weight of the dish plus residue was constant to within 0.05mg.

Total Suspended Solids (TSS)**Procedure**

Glass fiber filter paper of diameter 5.5cm was dried to a constant weight at 103-105⁰C in an oven, cooled to room temperature in a dessicator 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 wastewater sample was thoroughly mixed on a magnetic stirrer, after which 100ml was quickly measured into the filtering apparatus. After filtration elapsed, a pair of tongs was used to remove the glass fiber carefully from the Gooch funnel and then dried to a constant weight at 103-105⁰C. The weight was noted.

Total Dissolved Solids**Procedure**

Effluent sample was stirred with a magnetic stirrer and a measured volume was taken onto a glass fiber filter with applied vacuum. It was washed with three successive 10ml volumes of distilled water, allowing complete drainage between washings, and suction was continued for 3 minutes after filtration was completed. Total filtrate with washings was transferred to weighed evaporating dish and evaporated to dryness on a steam bath. Evaporated sample was dried in the oven for 1 hour at 180±2⁰C, cooled in a dessicator and weighed.

Oil and Grease by Gravimetry**Procedure**

The water sample was acidified previously at the sampling site (1:1) HCL to pH<2 or lower (generally, 5ml is sufficient for 1 liter sample). 200ml wastewater sample was transferred to a separatory funnel followed by the addition of 30ml n-hexane. It was shaken vigorously for 30 minutes for layers to separate. The n-hexane layer was drained through a funnel containing 10g Na₂SO₄ on a filter paper already rinsed with n-hexane. The extraction was repeated twice using 30ml n-hexane for each of the extraction. The funnel was rinsed with 10ml n-hexane after filtration in each case. All the hexane layers were mixed in a crucible already dried and weighed to a constant weight. The crucible was placed on a water bath until content evaporated completely. After which the crucible was placed in an oven for 5minutes. It was later removed and placed in the desiccator to cool and weighed. This was repeated until a constant weight was obtained. Blank was determined by taking 100ml n-hexane through the whole procedure.

Chemical parameters

Chemical parameters considered are : chloride, hardness, acidity and alkalinity.

Dissolved Oxygen

The amount of oxygen found by determination in a sample of water or wastewater at the time of collection is the dissolved oxygen (DO). Measurement was carried out by the use of Winkler's titration.

Procedure

The water sample was put in a 250ml bottle, followed by the addition of 1ml MnSO₄ solution and 1ml alkali-iodide-azide reagent well below the surface of the liquid. It was stoppered with care to exclude air bubbles and mixed inverting. It was allowed to settle for 2 minutes, after which 1ml concentrated H₂SO₄ was added by allowing the acid to run down the neck of the bottle, restoppered, and mixed by gentle inversion until dissolution was completed. At this stage, the iodine must have been uniformly distributed through the solution. 20ml of the solution was titrated with 0.0125M Na₂S₂O₃ · 5H₂O solution to a pale straw color. 1-2ml of starch solution was added, 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.

$$\text{DO (mg/l)} = 16000 * M * V / V_2 / V_1 (V_{1-2})$$

Where

M= molarity of the thiosulphate solution

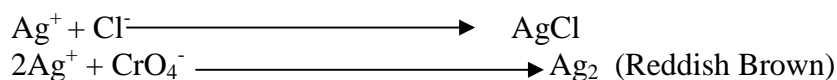
V= volume of thiosulphate used for titration

V₁= volume of the bottle with stopper in place

V₂ = volume of aliquot taken for titration

Chloride for Silver Nitrate Titration**Procedure**

25ml sample was measured and diluted to 50ml with distilled water. The pH of the sample was adjusted to 7.5 with H₂SO₄ followed by 1ml KCrO₄. The sample was titrated with 0.0141M AgNO₃ standard solution until the colour changed from yellow to faint red. Reagent was titrated blank using only distilled water without the sample.



$$\text{Cl}^- \text{ (mg/l)} = (A-B) * M * 35,450 / V$$

Where

A= volume of AgNO₃ used for titrating sample

B= volume of AgNO₃ used for titrating blank

M = molarity of AgNO₃

V= volume of sample

Acidity by Titration**Procedure**

25ml sample was titrated with 0.02M NaOH solution using phenolphthalein indicator at room temperature. 0.01M of H₂SO₄ was added to the sample to reduce the pH to 4 or less. 5 drops of 30% H₂O₂ was subsequently added to the sample and boiled for 2-5 minutes. The sample was

cooled to room temperature and titrated with standard 0.02M NaOH solution using 5 drops of phenolphthalein indicator.

$$\text{Acidity as mg/l CaCO}_3 = A * M * 100,000 / V$$

Where

A= volume of the titrand

M= molarity of titrand V= volume of sample

Alkalinity by Titration

Procedure

25ml sample was titrated with 0.01M H₂SO₄ acid solution using 3-5 drops of phenolphthalein indicator. The result was expressed as phenolphthalein alkalinity. Another 25ml sample was titrated with 0.01M H₂SO₄ with 3-5 drops of methyl orange indicator. Blank titration was carried out in both cases.

$$\text{Phenolphthalein alkalinity, mg/l CaCO}_3 = A * M * 100,000 / V$$

Where

A = volume of standard acid used

M= molarity of standard acid

V= volume of sample

$$\text{Methyl orange alkalinity mg/l CaCO}_3 = A * M * 100,000 / V$$

Where

A = volume of standard acid used

M = molarity of standard acid

V = volume of sample

Total Hardness by Calculation

The hardness of water is a measure of the capability of the water to precipitate soap. The precipitation of soap is chiefly due to the presence in water of calcium and magnesium ions. Precipitate of soap may also be due to other polyvalent metal ions such as Al, Fe, Mg, Zn and Sr and of course, by hydrogen ions. Natural waters contain calcium and magnesium only in significant concentrations. Polluted or wastewaters may contain all the metallic ions mentioned above in significant concentrations. The unit in which the hardness of water is expressed is mg/l CaCO₃.

$$\text{Total hardness mg/l CaCO}_3 = 2.497[\text{Ca, mg/l}] + 4.118[\text{Mg, mg/l}]$$

RESULTS AND DISCUSSION

The results obtained from the analysis of wastewater collected at the refinery outlets (point 1) and main outlet (point 2) outside the vegetable oil producing factory are shown in the Table below :

Table 1.0: Mean Concentrations of Physicochemical Parameters obtained at Point 1 and Point 2

PARAMETERS	UNITS	POINT 1	POINT 2	FEPA (TOLERANCE LIMIT)
Oil and grease	Mg/L	106	98	10-30
Hardness	Mg/L	198.65	162.74	<250
Chloride	Mg/L	405.1	333.3	600
pH	-	13.65	9.56	6-9
Suspended Solids	Mg/L	1.4	2.3	30
Dissolved Solids	Mg/L	17.3	4.7	2000
Total Solids	Mg/L	18.7	7.0	NS
Temperature	⁰ C	28	25	40
Alkalinity(methyl orange)	Mg/L	30	7.4	NS
Alkalinity (phenolphthalein)	Mg/L	17.2	4.0	NS
Dissolved Oxygen	Mg/L	-	-	NS
Acidity phenolphthalein	Mg/L	17.2	4.0	NS

Table 1.1: Mean Concentrations of Heavy Metals obtained at point 1 and point 2

HEAVY METALS	UNITS	POINT 1	POINT 2	FEPA (TOLERANCE LIMIT)
Chromium(Cr)	PPM	0.18	ND	<0.25
Manganese(Mn)	PPM	4.55	3.59	<5.0
Cobalt (Co)	PPM	0.28	0.02	NS
Lead (Pb)	PPM	16.26	21.11	<0.2
Iron(Fe)	PPM	53.7	15.4	NS
Zinc(Zn)	PPM	0.08	0.05	<5.0
Copper (Cu)	PPM	0.66	0.20	<2.0
Nickels (Ni)	PPM	0.80	ND	<1.0
Cadmium (Cd)	PPM	1.47	ND	<0.03

From the results obtained, it can be observed that the level of cadmium, lead and iron in the wastewater samples was high when compared to the level of other metals in the samples. The high level of lead in the sample can be said to be from the parts of the equipment or machinery used at different stages of the production of the vegetable oil.

The high level of cadmium and iron in the samples can be attributed to the presence of abandoned metal scraps at the site of the wastewater outlets. The high concentration of these metals could have adverse effect on the aquatic life and man in general.

It can be observed that the following parameters : pH, SS, TDS, TS, Chloride, Oil and grease, Temperature, Alkalinity, Acidity and Hardness determined , are higher at point 1 than point 2. This is due to the fact that the sample collected at point 1 (refinery outlet) is highly coloured and turbid and may contain high pollution load due to its closeness to the production outlets. While the sample collected at point 2 has been diluted from wastewater from other sources in the factory. High level of lead at point 2 can be attributed to vehicular emission since it is closer to a busy express road and also gasoline and petrol used by vehicles contain organic lead as an anti-knocking agent. These may be released as particulate when the fuel is burned.

CONCLUSION

The study showed that effluent from vegetable oil producing industry contains some hazardous substances e.g. lead, cadmium and iron. Their concentrations exceeds the permissible limit of

national and international standards, hence, the effluent should be treated and the concentration of some or all of the hazardous substance should be reduced before the effluent are discharged into the environment so as to circumvent their adverse effect on aquatic life and man.

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