#### ENVIRONMENTAL IMPACT ASSESSMENT OF EFFLUENTS FROM A FERTILIZER PLANT

#### A CASE STUDY OF

# FEDERAL SUPERPHOSPHATE FERTILIZER COMPANY (FSFC), KADUNA

### RESEARCH THESIS

BY

SENEWO GBENGA REG.NO. 91/1937

### SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE BACHELOR OF ENGINEERING (B.ENG) IN CHEMICAL ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY,

P.M.B. 65,

MINNA, NIGER STATE.

NIGERIA

FEBRUARY, 1998

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### DECLARATION

I, Senewo Gbenga (91/1973) do hereby declare that this thesis is the result of my work and effort and it has never been submitted anywhere for award of any degree.

All literature cited and extra information received in carrying out this work have been duly acknowledged in the reference.

SIGNATURE

SENEWO GBENGA (91/1937) FEBRUARY, 1998

### CERTIFICATION.

This research thesis as an original work under taken by SENEWO GBENGA (91/1937) has been examined and certified under the supervision of DR. F. Aberuagba of the department of Chemical Engineering, SEET, FUT Minna and found to be adequate in scope and quality following the requirements of the department of chemical Engineering, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA for the award of degree Bachelor of Engineering (B.ENG.) in Chemical Engineering.

(Project Supervisor) Dr. F. Aberuagba

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(Head of Department Dr. K.R. Onifade

(External Examiner)

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Date

Date

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Date.

### **DEDICATION**

To the glory of my God, Lord and Savior Jesus Christ by whom I am and for whom I live, and to my loving parents Mr & Mrs B.F. Senewo who laboured and sacrificed for me to have this valuable endowment.

### ACKNOWLEDGEMENT

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Above all, my whole life and being is indebted to my Lord and savior for seeing me through everything without him, I am nothing, but through him, I have a goodly heritage and the lines are fallen to me in pleasant places, therefore he is my portion in the land of the living.

### ABSTRACT.

This project is an attempt to determine the impact of effluent water released from the production of superphosphate fertilizer on the environment using the Federal Superphosphate Fertilizer company Kaduna as a case study.

In carrying out this work, samples of water upstream the receiving drain, the effluent discharge at the outfall and downstream the drain were collected and analysed. The analyses of the major constituents as stipulated by FEPA in the effluent were conducted and compared with the FEPA limit, the same analysis were also conducted on the upstream and downstream samples and the results compared to evaluate the degree of impact caused by the namely temperature. PH content dissolved solids, suspended solids, calcium and phosphates content were analysed using standard methods and instrumental measurements. Of these the phosphate content found (74.6MQL) suspended solids (170mgl) and PH(5.93) all of to be the effluent were found to be higher than the FEPA stipulated limits. The others temperature (20c), dissolved solids (300mgll) and calcium as CaCo3, (184ppm) were found to be within the FEPA stipulated limits.

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#### CHAPTER ONE.

### 1.0 INTRODUCTION.

Development is essential for economic well being of any people in pursuing development, humans alone have the capability of gathering resources from beyond their immediate surroundings, processing them into different and more versatile forms. Early humans used natural resources to satisfy their needs for water, food and shelter, these unprocessed resources were readily available in the biosphere with the residues generated by the use of such resources being generally compatible or readily assimilated by the hence environment impacting the environment in a very relatively slight degree. Beyond satisfying natural needs and going on to satisfying acquired needs. Pollution overloads began to be observed in significant measures. Acquired needs are met by items that must be processed manufactured or refined and as a rule, generates more residuals which are less compatible with the environment and less likely to be readily assimilated into the biosphere. This erstwhile was supposed to be in a state of natural equilibrium with its life forms but has now began to show stress primarily because of human activities on the environment.

The coming of the industrial revolution brought about the establishment of many production process amongst which later included the various process for the production of fertilizer.

Fertilizers are materials added to the soil or directly applied to foliage to supply elements needed for plants nutrition.

Because of the depletion of soil nutrients on the earth due to farming and other uses, the addition of fertilizer to soil used for the production of crops is necessary to correct natural deficiencies and to replace the components absorbed by their growth.

These groups of substances nitrates, phosphates and pottasium in compounds are essential as agricultural fertilizer. They all undergo different process of production during which chemical inputs in the forms of raw materials, additives make up water and other utilities are utilised to obtain both the wanted and unwanted products.

Fertilizer production processes emit gaseous, liquid and solid wastes which are possible sources of air, water and soil/land pollution. Gaseous waste come in the form of oxides of Sulphur, Fluorides, Chlorides Salt of ammonia, oxides of nitrogen and dust. Liquid wastes are in the form of oganics, fluorides, phosphates, salt of ammonia, oxides of nitrogen cadinium and heavy metals. Solid waste are mostly in the form of gypson.

The scope of this project has been restricted to the production of single superphosphate from the Federal Superphosphate fertilizer company Kaduna with its attendant effluent discharge and their impact to the environment based on the interpretation of results obtained being compared with standard effluent limits based on guidelines set by the Federal Environment Protection Agency (National Guideline and Standards for industrial effluent, Gaseous Emissions and hazardous waste management (1991).

The target environmental descriptor that may suffer any irregularies arising from the effluent discharge here is the receiving stream which also receives effluent from the surrounding textile factories and domestic discharges.

In analysis the impact of the effluent (with its constituents based on the parameters of significance from FEPA set guidelines) a sample of water upstream the receiving drain, the effluent discharge as well as a sample of water downstream were collected and analysed.

The result of the effluent discharge was compared directly to that set by FEPA for phosphate fertilizer industry (Table 2) where there were non-stipulated it was compared with that set for all categories of industries and as well as the comparative figures of limits for subtances affecting the acceptability of water for domestic purpose (W.H.O International Limits). Also the results of the stream, to the discharge and discharge to the downstream were compared to see if there was undesirable inputs from the effluent into the receving water body prior to discharge.

Logical conclusion were made to imply the effect of the effluent to the environment.

### LITERATURE REVIEW.

2.0,0

#### WHAT IS AN ENVIRONMENT IMPACT ASSESSMENT?

The necessity to anticipate potential environment problems so as to avoid them or to reduce their effects requires a thorough appraisal of an environmentally significant action before it is taken. The formalisation of this concept is embodied in environmental impact assessment process.

The term EIA stems from the U.S National Environmental Policy act 1969 and basically is an attempt at evaluating the consequences or impacts of a proposed action on the environment, it is likely to affect and usually alongside, the pulication of this for widespread review. It requires a systematic, reproducible and interdissciplinary approch.

### 2.0,1 BASIC FUNCTION OF AN EIA.

- Describe proposedl activity.
- Relate activities to planning or agency regulations.
- Analyse primary (Direct) and secondary (Indirect) environmental impacts. These may ne physical, ecological, social or aesthetic.

- Generate alternatives to reduce impacts
- Provide a process for a participating planning activity between enterprise, government and the community.

### 2.0,2 EIA PROCEDURES.

EIA procedures have been reduced to four basic steps.1. Identificatrion

2. Prediction

- 3. Evaluation.
- 4. Communication.

### STEP.

### KEY ELEMENTS

1.	Identification -	- Description of the existing environment.
		- Determination of project components
		- Definition of the environment as modified by project.
2.	Prediction.	- Identification of environmental modifications that may be significant.

- Forecasting the magnitude and/or spatial dimensions of identified change in the environment.
- Estimation of the probability that the impact (environment change) will occur.

 Determination of the incidence of costs and benefits to user groups and populations affected by the project.
 Specification and comparison of the trade offs (Cost of ffects being balanced between various alternatives.

- Publish draft EIA, invite comments, final EIA integrates comments and justified decision.
- 4. Communication

3. Evaluation

6

#### 2.03 CONSTRAINTS.

Several constraints are usually experienced in the execution of an EIA, among which are

- a) Collection of supporting baseline data for an EIA may be expensive difficult.
- b) Absence of set guideline for particular pollutants of interest from regulating agencies.
- c) Long delay assciated with EIA studies.
- d) Lack of a well committed interdiscriplinary effort.
- e) Absence or scarcity of equipment and analytical instruments for analytical determinations coupled with the dearth of skilled personel to handle such.

Usually an EIA should describe the impacts associated with the construction and operational phases of a proposed action, considering the former to be short term in effect and the latter long term. The focus on this project however is on the operational phase (Fertilizer production of superphosphate) and the effects of the associated effluent discharge.

### 2.04 WHY E.I.A (10)

The original intention of the environmental policy act (at least in principle) was to ensure that all the major impacts of an action significantly affecting the environment were evaluated so that the decision to proceed with, to abort or to modify the action could be taken on basis of information acquired/given.

Protection of individuals working in a industry, the public in general and property as serious considerations given to in an EIA, other are the general biotic life forms and constituents of the biosphere. Waste gases such as those containing toxic substance eg arsenic or lead fumes constitute a serious danger to health of plant operatives and surounding pupolation. Others containing flourine compound and  $SO_2$  may kill plants; damage painwork and buildings or merely discolour wall paper and curtains making an industrial town less pleasant to live in.

#### THE ENVIRONMENT

2.1.0

The environment in a broad sense is viewed as a stock of physical and social resources available at a given time for the satisfaction of human needs. In another way it is simply defined as one's surroundings which can take a global dimension or it may refer to a localized area wherein a specific problem must be addressed.

It is made up of the hydrosphere and the biosphere ( a thin shell encapsulating the earth and comprising the atmosphere and lithosphere) wherein exist the life forms of the earth including the life sustaining resources. [2].

2.1.1

### THE ENVIRONMENT, TECHNOLOGICAL DEVELOPMENT AND IMPACTS.

In a natural state, the earth's life forms live in equilibrium with their environment with natural systems having the capacity of restoring quality for every natural act of pollution and alteration on the physical, chemical and biological characteristics of the environment [5]. However in recent years, it has become apparent that the sustaining and assimilative capacity of the biosphere has begun to show stree primarily because of the impact of human on the environment due to the generation of natural and manufactured wastes, the upsetting of natural equilibrium and the consequent thrive of anthropogenic or human induced pollutants in the system.

The situation has gone two ways already, as humans interact with and adversely impact their environment they're in turn being adversely impacted by pollutants released into the environment.

As has been stated earlier on, technological [5] development and advancements are essential to human survival and well being, however it is simply not desirable to pursue development strategies that are not sustainable over a long term basis due to serious environmental damages its development should proceed without undue destruction. Any form of development in order to be self sustaining must be based on environmentally sound practices in relation to their natural resource base (its of soil, water, plant and animal life). Technological development is now viewed as a process pursued by all societies with the aim of increasing human well being with the stock of physical and social resources available [5].

Once again the question really shouldn't be whether projects (developmental or technological) be carried out because they'll affect the environment (invariably most always will) but how much charge is acceptable to the society as a whole and what counter measures should be taken to keep the adverse changes to a minimum.

2.2.0

### POLLUTION OVERVIEW.

The natural environment has a large capacity for handling waste automatically (ie to accommodate pollution to an extent) by natural process of oxidation and bacterial decay. It is when the

quantity of waste overload becomes to large for the natural system of compensating reactions to be handled expeditiously or when substances hazardous to health make up in sizable fraction of the waste that the problem begins to demand attention.

Population generally ignore the impact of human activities on the environment until they begin to get aware of the ill effects that a polluted environment can have upon their health and well being.

Air pollution may occur in the form of gases, liquids and solids both singly or in combination. Gaseous pollutants make up about 90% of the total mass emitted to the atmosphere with particulate and aerosols accounting the remaining 10%, small particulate are of particular importance because they may be in the respirable size range and contain biologically active elements and compounds and harmful to health.

Furthermore, they tend to remain in the atmosphere where they interfere with both solar and terestial infra-red radiation which may affect climate on a global basis. Polluted rivers, smoggy skies and unsightly land dumps apart from being aesthetically displeasing exert equally negative impacts on the health; aesthetic and cultural pleasures and economic opportunities of man.

The widespread use of chemicals in agriculture and industry has introduced many of these compounds into the environment, others

concentrated at disposal sites have also been spread through food chains posing a potential threat to all humans. It has been demonstrated that the animal incidence of respiratory disease is directly proportional to the annual sulphur oxide level, (Sulphur oxides, carbon monoxide, nitrogen oxides hydrocarbons and particulate matter have been largely recognized now as the major pollutants to the atmosphere) where it has also been found that deaths from respiratory causes are more frequent in populations exposed to higher levels of these oxides.

Urban dweller have almost been denied the aesthetic pleasure of clear air, sparkling lakes, stream and rivers. On a global front the mere evident cases of the ozone layer depletion with the attendant result of skin cancer or humans, the green house effect which is characterized by a gradual global warning (World temperature expected to be raised by up to 2<sup>0</sup>c by 2050) and many other undies of pollution all stemming from various human activities are glaring.

Pollution also causes an economic threat to all human populations due to the destruction of various resources that needed and employed for the up keep of life. In a nutshell, a polluted environment possess risks to health of all biotic forms, economic well being of man as well as threat to aesthetic and cultural enjoyment.

2.2.1

## POLLUTION IN THE FERTILIZER INDUSTRY.

Artificial fertilizer production which began after the industrial revolution, being used to replace animal wastes has come a long way in the deign and fabrication of processes used in manufacturing such; The basic raw materials used especially for phosphate fertilizer production contain a wide range of trace elements present in unbalanced proportions. The excesses of these unwanted elements as well as those of the desired most time make for the sources of pollution.

Generally fertilizer production processes emit gaseous, liquid and solid wastes as possible source of air, water and soil pollution. Air pollution is caused mainly by the emission of nitrogen compounds and fluorides which in air is extremely poisonous, others are Chlorides, Oxides of Sulphur and dust liquid pollutants are organices, Fluorides, Phosphate, Ammonia and  $No_x$ , Cadmium and heavy metals Solid Pohosphozypsum.

### 2.2.2

### IN SUPERPHOSPHATE PRODUCTION.

In the production of superphosphate air pollution is caused by emission of fluoride and dust arising from handling and grinding of phosphate rock; the fluorides (HF and  $SiF_4$ ) are emitted from dens (reactors) and evaporators. Solids are the main sources of water pollution. The liquid discharge is usually from the gas scrubbers and from the waste water treatment area. Solid pollutants are

hardly ever encountered in the production of superphosphate except the sludge deposits acquired from in-plant abatement and treatment activities.

Generally it has been found that approximately 85% of industrial phosphorus discharge originates from phosphoric acid production (which most times goes along with manufacture of superphosphate) where as the other 15% originates from various types of industries such as food agricultural and chemical.

### 2.30 POLLUTION CONTROL.

Various measures may be employed to reduce emission of pollutants from production processess e.g. Installation of gas scrubber, dust collectors, system for recycling of process waters and good house keeping methods.

Accidental or point source emission should be separated from other streams such as cooling water and storm water can be treated or recycled. Cooling water may be contaminated by accidents in the production process, if the cooling water is recirculated, it is possible to treat or recycle the accidentally contaminated cooling water, hence the importance of recycle operations in chemical process industries cannot be dismissed with a wave of the hand, usually process stream which may be re-used usually have to be concentrated before actual recycling to the production process, this aspect causes an increase of the production cost but is paid off in other aspects and the eventual conservation of still useful resources.

# 2.3.1 POLLUTION CONTROL SUPERPHOSPHATE MANUFACTURE.

Dust emission are reduced by treating the off gases from rockhandling and rockgrinding in several types of dust filter. Formation of dust may be prevented by gringing the phosphate rock underwet conditions. Fluoride emissions are reduced by scrubbing all off gases containing fluorides removal efficiency by scrubbing is approximately 99%. The condensate from evaporations may have a concentration of  $70f/m^3$  which has a commercials value. According to survey result from EFMA, the discharge of effluent water and pollutants (F,P) can be reduced (100%) by total recycle of all offgases, fluoride recovery (H<sub>2</sub> Si F<sub>6</sub>) and scrubbing water

### 2.3.2 ENVIRONMENTAL QUALITY STANDARDS AND AGENCY REGULATIONS.

The original intention of the U.S. EPA (at least in principles) was to ensure that all the major impacts of an action significantly affecting the environment were evaluated so that standard and guidelines could be set to monitor the activities and qualities of pollutants release.

Environmental quality standards refer to limits of ambient environmental quality that cannot be exceeded without infringing on statutory laws' Its apparent that if an area have pollution level higher than the environment quality standards, then no new emissions should be permitted and stem actions should be taken to reduce existing emissions. such standards therefore have a very profound role to play in guiding industries and those involved in production with the consequent generation of water.

However there must be strict agency and the guideline should have a specific goal/ objective e.g a stated goal in the water pollution control in the united states is that all surface waters in the U.S. must be maintained at "Fishable, Swimmable" quality. Attainment of this goal should result in a quality sufficient for most water uses and the simplifying of treatment process for water intended for portable and industrial use.

National effluent limitations and gaseous emissions guidelines in Nigeria for specific industries can be found in table 3 of appendix B.

Monitoring of effluents and emissions and surveillance activities are the sole responsibilities of the Federal Environmental Protection Agency.

3.0.0

# BRIEF HISTORY OF THE COMPANY AND ITS ACTIVITIES.

The Federal Superphosphate Fertilizer company Ltd is wholly owned by the Federal Government of Nigeria. The company was incorporated in 1973 and it went into production (manufacture of single superphosphate brand of fertilizer -SSP) in 1976. It has since been operating fairly successfully. The FSFC was originally designed to produce SSP to the Nigerian farmer particularly the Sahelian sub-region. The designed capacity was for 100,000 metric tonnes per year of SSP and 42,000 metric tonnes per year of industrial grade sulfuric acid. Both units of the plants were producing successfully until recently when there became a need to revamp the he facilities to enhance the productive capacities of the units.

Over the last fifteen years (as at 1997) the R and D section of the company had successfully produced a member of downstream industrial chemical products which have found very economic use in the local markets. The products include among others, chemicals like Sodium Polyphosphate, Dicalcium Phosphoric, Phosphoshuoric acid, Calcium Hydroxide (hydrated lime), Calcium Sulphate and alumimium Sulphate (alum). Both the alum and hydrated line are used extensively in water treatment. The company is located in Nassarawa in the industrial area of the southern part of Kaduna town.

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Raw Materials:
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1. Phosphate Rock. Analysis on dry weight basis  $P_2O_5$  : Min 36.81 %

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CaO : max 51.29%
 SO3 : Max 0.4%
 CO<sub>2</sub> : Max 1.53%
 Silicious matter: Max 3.76%
 Fe<sub>203</sub> : Max 1.21%
Al_2O_3 : Max 0.95%
MgO : Max 0.08%
MgO
          :
               Max 0.08%
Na<sub>2</sub>O : Max0.25%
K<sub>2</sub>O : Max 0.06%
Cl<sub>2</sub> : Max 0.08%
F
          : Max 3.95%
Calcining Loss: Max 2.59%
Moisture : Max 1.00 (Assumed)
2. Sulphuric Acid:
    Purity 98%
3. Lime Milk
    Ca(OH)<sub>2</sub> : 5%
    H<sub>2</sub>O : 95%
```

### 3.1.1 PROCESS DESCRIPTION.

The single superphosphate plant is to produce 334 metric tonnes of granulated SSP fertilizer per day from phosphate rock 98% sulphuric acid based on the Nissan continuous development process. It consists of

- Rock grinding section
- Adulation section
- Granulation section
- Bagging section
- Effluent gas and waste water treatment unit.

#### ROCK GRINDING:

The phosphate treatment rock is fed to a grinding mill and palverized to the degree suitable for reaction then stored in ground rock hoppers.

### AUDULATION: -

The ground rock is weighed with a ground rock weigher and continuously fed into the premixer through dilution cooler. In the premixer, sulphuric acid is sprinkled on the phosphate rock and mixture of the acid and the rock becomes a scurry. The scurry is further agitated by a mixer with the resultant scurry fed into the moving bed of continuous den where reaction takes place to form crude porous, solid single superphosphate. The evolved gases containing fluorine compounds are drawn by an exhaust fan and washed in the effluent gas treatment unit. The hardened layer of SSP in the den is now sliced at the outlet and piled for curing.

### GRANULATION : -

After curing, the mature product is conveyed to the granulating section consisting of granulating, drying and screening. The mature product is screened mature materials is fed into a granulator together with the recycled powder. The obtained granular product are dried to low moisture content and then sieved. The obtained granular products size granular are cooled down to approximately  $50^{\circ}$ C to prevent caking in the course of stocking after which it is bagged.

### 3.2.0 <u>EFFLUENT AND EMISSION GENERATION, GAS AND WASTE WATER</u> TREATMENT

In the digestion of phosphate rock by sulphuric acid in the den (which acts as a reactor) there is a generation of hydfluoric acid gas (HF) which reacts in turn with silicon IV oxide  $(SO_2)$  contained in the phosphate rock to form silicon tetraflouride  $(SiF_4)$ . This gaseous effluent from the continuous den is washed with water in a spray chamber, jet scrubbed and then washed with caustic soda (NaOH) solution in a turbulent contact absorber.

By a series of these scrubbing steps, it is expected that most of the fluorine compounds in the gas are removed and the washed gas is exhausted to the atmosphere. The effluent gas from the dryer is also washed with caustic soda solution in a turbulent contact absorber and exhausted to atmosphere.

The water used for the above mentioned washing are transferred to the neutralizer where neutralization takes place using lime milk produced from the kiln unit. After neutralization, the treated waste water is retained in a settling pond to effect separation of sludge by sedimentation. Most of the water is recycled to the effluent gas treatment process for making up of the washing water and for slaking quick lime, and the remaining water which constitute the effluent water overflows out of the settling pond into the drain.

### 3.3.0 CHEMICAL REACTIONS.

In SSP fertilizer manufacture, the principal aim is to produce phosphate compounds that are easily and readily available to plant life, and the principal result of audulation is the formulation of monocalcium phosphate monohydrate and calcium.

 $Ca_9 (PO_4) CaF_2 + 7H_2SO_4 + 3H_2O -> 3CaH_4 (PO_4)_2 H_2O$ + 7 CaSO<sub>4</sub> + 2HF.

Hydrogen fluorine (HF) formed during the reaction above reacts silicon IV oxide contained in phosphate rock to form silicon tetrafluoride,  $SiF_4$ .

 $4HF + Si)_2 -> SiF_4 + 2H_2O$  -(ii).

### 3.3.1 <u>EFFLUENT TREATMENT.</u>

The gaseous silicon tetrafluoride is scrubbed with water and caustic soda solution in the effluent gas treatment section in order to avoid serious air pollution problems.

 $3 \operatorname{SiF}_4 + 4\operatorname{H}_20 -> 2\operatorname{H}_2 \operatorname{SiF}_6 + \operatorname{Si}(0\operatorname{H})_4 - (\operatorname{iii})$  $\operatorname{SiF}_4 + 4\operatorname{Na0H} -> 4\operatorname{NaF} + \operatorname{Si}(0\operatorname{H})_4 - (\operatorname{iv})$ 

During the first reaction, all the carbon dioxide contained in phosphate rock are also evolved.

4.0.0

### METHODOLOGY AND RESULTS.

According to FEPA (National guidelines for Industrial Effluents, Gaseous Emissions and Hazardous waste management 1991). The most significant parameters to be analysed in the effluent from a phosphate fertilizer industry are pH, temperature, suspended solids, calcium, phosphate and fluoride contents [3].

For the purpose of this project three samples of water were analysed labelled A,B, and C Sample A was collected 2M before the outfall ie upstream the discharge.

Sample B is the effluent discharge and sample C was collected 2M (ie downstream) after the outfall. The choice of this is to justify the representativeness of the sample as just beyond this point witnesses the discharge of other domestic drains. These were all collected in plastic bottles and stored in a refrigeration till analysis.

### 4.1.0 ANALYSIS.

Two major types of analysis were carried out on the effluent water constituents.

i. Physical

. 11:5

ii. Chemical Determinations.

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1.1.5

. <u>i</u>.

1.

### 4.2.0 METHODS

The Methods used were Standard  $p^H$  meter for  $p^H$  measurement, thermometer for temperature, gravimetric analysis for the suspend and dissolved solids and standard tests for determining calcium using titrimetry and colrimetry for the phosphates.

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### RESULTS

PARAMETER	: A : : UPSTREAM :" : :	B EFFLUENT DISCHARGE	: C : DOWNSTREAM :
p <sup>H</sup>	9.13	5.93	9.14
Temperature	22°C	20°C	22°C
Total Dissolved Solids (mgll)	620	300	: 580
Total Suspended Solids (mgll)	340	170	: : 440 :
Calcium as CaCO <sub>3</sub> (ppm)	: 126	184	: : : 144
Phosphates (ppm)	45.6	74.6	41.4

Specific Results are tabulated in the Appendix A as well as obtainable in Appendix C were methods for the chemical analyses were described.

Also comparisons of results obtained with FEPA Standards are obtained in Appendix A (Table 2)

.

Ξ,

A = Water Sample Upstream

B = Water Sample of Effluent

C = Water Sample dowstream.

5.0.0

### DISCUSSION OF RESULTS.

The result of the analyses carried out shows in comparison with FEPA standard limit that of the parameters analysed only three were within the stipulated limits (Table 2) for phosphate fertilizer industry standards; these are the temperature, calcium content and suspended solids. Where there were no stipulated standards for phosphate fertilizer, the result of the effluent was compared with that outlined for all categories of industries as well as W.H.O international Standards. (Table 2) as documented by in the FEPA guidelines [3].

### CONSTITUENTS AND THEIR IMPACT.

### 5.1.0<u>pH</u>

It is the negative logarithm of the hydrogen ion concentration of a substance and is a critical factor in determination of effluent characteristics as the concentration range suitable for most biological life form existence is quite narrow.

From the result determined, the pH (5.93) of the discharge is quite close (although not) to that stipulated. In comparison with the upstream and downstream, there is no much variation as shown by the value of 9.13 and 9.14. The hydrogen ion concentration of the effluent can be said to be within acceptable range.

### 5.1.1 <u>TEMPERATURE</u>.

The temperature of water is very important because of its effect on aquatic life, chemical reactions and suitability of water for beneficial uses. Oxygen is less soluble in warn water than cold water.

The result of temperature determined for all the sample  $22^{0}$ c for the upstream,  $20^{0}$ c for the effluent and  $22^{0}$ c for downstream water sample were all within the stipulated range, hence it is deduced that there is less impute from the effluent or otherwise reactions within the system that can unduly raise the temperature and negatively impact the water body.

### 5.1.2 DISSOLVED AND SUSPENDED SOLIDS.

Suspended solids is a measure of solid particles in water that do not dissolve in solution and are recovered by evaporative processes.

From the analysis conducted, the dissolved solids for the effluent was found to be 300 mgll and accordingly within stipulated limits; however that of the suspended solids, (170mgll) was grossly beyond the limit and may be said to add to saline effect/content of the receiving water body of note however is that on analysis found to be 620mgll and 580mgll respectively as well as that of the dissolved solids for the same points 340mgll 440mgll were quite higher than that of the effluent, hence it was deduced that prior to discharge, the stream was already affected by a high input of

suspended matter. This can be adjudged to emanate from the effluent of the surrounding textile factories which also discharge directly into the stream and have an associated problem of high discharge of suspended solids, (Table 3).

The high concentration of suspended solids can lead to development of sludge deposit and anaerobic conditions and turbidity.

This can further prevent transmission of light leading to obstruction of photosynthetic activities in the aquatic environment. Treatment for water domestic purposes also becomes costly.

### 5.1.3 <u>CALCIUM</u>

Calcium content upon determination was found to be 184mgll (as  $CaCO_3$ ) and hence within the stipulated limit of 200mgll. The effect of excess calcium in water is hardness of water and consequently high cost in treatment of water for domestic purposes, scale formation is boilers and reactor vessel are also associated problems.

### 5.1.4 PHOSPHATE.

Phosphate of all parameters analysed, the phosphate content of the effluent found to be 74.6mgll was most beyond the set limit of 3mgll. The upstream and downstream were found to be 45.6 and 41.4mgll respectively also beyond the stipulated limit. Hence it can be said that the release of phosphate into the water body is adversely impacting the environment (water in the case). Excessive amount of phosphates cause nutrient enrichment of the water body and avenues for growth of unwanted biotic species of note is the avenue for growth of algal bloom caused by eutrophication and an increase in cost of water treatment especially for domestic purposes. Eutrophication is the slow ageing process during which a lake estuary or bay evolves into a big or marsh and eventually disappears developing to a choke of abundant plant life. Although upon inspection this was not evidently present, its unusual high amount as compared with stipulated limits gives enough reason to raise brows for caution.

### 5.1.5 FLUORIDE.

The fluoride content of the samples were not analysed however, result from past record from the R and D of the company showed that for analysis carried out between 1985 - 1990 on the exhaust fan out, an average of 2.06ppm overall was obtained indicating an exceeding of the FEPA standard of 1.0. Fluoride though an essential element for some animal species in terms of fertility and growth rate can be dangerous in excessive amounts. The most direct implication so far has been on the plant operatives due to the

uncontrollable fluorine gas released in the curing of superphosphate pile. Reference to diagram of flowsheet for gaseous emission points of fluoride compounds during production. Other effects resulting in excessive release of fluorine are dental and skeletal floursis giving rise to crippling effects and mottling of teeth. Pathological effects include haemorrhagic gastoenteritis, acute toxic nephritis and varying degree of injuring to liver and heart mussel. Fluoride also harm plant in concentrations as low as five parts per thousand million for 7 - 9 days continuous exposure [1].

As a matter of fact, animals are mostly affected when they consume containing foliage harmful levels of fluorine. Fluorides cause eve irritations, nose bleeding, inflammations of the respiratory tract and severe difficulty in breathing. [8]. 6.0.0

### CONCLUSION AND RECOMMENDATION.

The assessment of the impact of effluent discharge from a fertilizer plant using the FSFC as a case study has yielded a quite reasonable result.

The main source of constituents of effluents from processing industries have been found to be from loss of raw materials (and even products) during manufacture. Most of these usually contain metals, non-metal, trace elements and toxic materials in combination, the removal of excesses of which make up constituents of effluents. The use of inorganic chemical also contributes in generation of effluents.

In the execution of the analysis the most attention was given to water analysis of the effluent as about 90% of the parameters of major importance as outlined by FEPA. In the analysis of phosphate fertilizer effluent was contained in water. The exception, fluorine impounds could be analysed as a gaseous component also in the liquid.

Test carried out on the effluent discharge and water sample equidistant upstream and downstream the outfall were analysed and

on the overall the result have show that the impact of the effluent discharge from the plant on the environment is mild.

Only about 50% of the test parameters were found not to conform with the stipulated standard by FEPA. The primary target of the effluent discharged is the receiving water body. The sufferers are the biotic life forms which thrive in the water, for example, because of the excess phosphate being discharge into the water, eutrophication may set in bringing about enrichment (Nutrient) of the water, algal blooms and de-stabilization of the energy cycle. Secondary sufferers may be humans who fish in the water, employ the use of the water body in this case although much of which is contributed by the discharging effluent from the textile and domestic sewers close by.

Air pollution is not widely spread around here except within the plant, the primary sufferers being the plant operatives that suffer from pollution caused by fluorine emissions contained in waste gasses when phosphate rock is being treated in the dens (reactors) and also during the curing of superphosphate in the pile. Dust and particulate emissions may also endanger health during the process of grinding of phosphate rock and in cases of disproportionate release due to malfunction of abatement facilities eg Cyclones.

### RECOMMENDATION.

6.1.0

The delicate balance of the biosphere has been disturbed and the state in which humans now find themselves is a direct consequence of our having ignored the limits of the earth's ability to overcome heavy pollution overloads and of our having been ignorant of the constraints imposed as the limits of the selfcleansing mechanism of our biosphere. In all instances, the end products of the treatment of polluted water, air or disposal of solid wastes must be compatible with the existing environmental resources and must not overtax the assimilative powers of the biosphere. However as stated earlier, development in all forms is essential for the economic well being of any people. The question then is not whether there should be development but rather how to meet basic human needs and aspirations of a populace without simultaneously destroying the resource base, that is the environment from which these needs must be met.

In dealing with population problems arising from the manufacture of superphosphate fertilizer production processes, a basic and good starting point is in the development of clean production processes. The purpose of this is produce pure products by products which do not damage the environment, it ca be realized by using purer phosphate rock of the magmatic origin, however this may be realistically impossible because the world reserve of such type is very limited.

### 6.1.1 WASTE - WATER TREATMENT.

A great deal of the problem involved with the pollution of the environment with respect to superphosphate effluent water (as observed from this work) is in the constituents of the waste water. Chemical unit processes are applied here in the treatment of waste water, however probably due to cost, the right dosages seem not to be applied and at appropriate times. The principles of waste water treatment which are to convert objectionable materials to other less objectionable forms to disperse pollutants so that their concentrations are minimal or to concentrate them for isolation from the environment must be seriously adhered to in the designing of efficient control and treatment devices.

### 6.1.2 <u>RECYCLING.</u>

Total recycle of all off-gases and scrubbing water is of great importance in curing the pollution problems associated with effluent water discharge from SSP production, installation of gas scrubbers, dust collectors, systems for recycling of process waters should be put in place. Although most of these are already in place, a good number of them are however defective probably due to lack of adequate maintenance.

Accidental or point source emissions should be separated from other stream such as cooling water and storm water to be treated and recycled.

## GOOD HOUSE CLEANING METHOD.

Good house - cleaning methods should be put in place as well as being adequately adhered to.

### 6.1.3 AGENCY MONITORING

Another important aspect in dealing with problem of pollution from fertilizer effluents is the role to be played by regulating agencies, in this case FEPA; Actually attempts made to get data from FEPA with respect to this project failed as they themselves were not in the position to give such being that no analysis has been carried out for a long time on the company's effluent water. This of course encourages slackness on the part of the industry as to checking any excesses of pollution being caused by their effluent water. Another problem this causes is a lack of systematic measurement of pollution aimed at coordinating relevant information in order to produce a national plan and establishing orders of priority for remedial work. Only by systematic monitoring of chemical, physical and biosgical parameters together with flow monitoring is it possible to assess the extent of pollution for control purposes or to determine the best, most economical strategy in the management of various resources. Therefore not only must there be set guideline and permissible limits are regarding effluent discharge (as there is now) but the agency must ensure that there is a strict compliance by industries to those set limit with appropriate penalties faced in areas of defaulting.

Finally in dealing with the pollution problems of overload, one must work within the constraints of natural laws using all available technological tools to deign efficient control and treatment devices that are modeled after the natural processes that so long preserved our biosphere.

Only by bring technology into harmony with the natural environment can one hope to achieve the goals of protection of the environment from the potentially deleterious effects of human activity, the protection of human populations from the effects of adverse environmental factors and the improvement of environmental quality for human health and well being.

### APPENDIX A

(RESULTS

### RESULTS.

### TABLE 1.

PARAMETER	A UPSTREAM	B	DISCHARGE	C DOWNSTREAM
РН	9.13	5.93		9.14
Temperature	22 <sup>0</sup> C	20 <sup>0</sup> C		22 <sup>0</sup> C
Total Dissolved Solids(mgll)	620	300		580
Total Suspended Solids(mgll)	340	170		440
Calcium as CaCO <sub>3</sub> (ppm)	126	184		144
Phosphates (ppm)	45.6	74.6		41.4

A = Water Sample Upstream

B = Water Sample of Effluent

C = Water Sample downstream

### TABLE 2

Comparison of results with FEPA standard (for phosphate fertilizer producers, all categories of industries) and W.H.O limits for substnaces affecting the acceptability of water for domestic purposes.

PARAMETER	EFFLUENT	FEPA FOR PHOSPHATE FERTI- LIZER INDUSTRY	FEPA FOR ALL CATEGORIES OF IND SRTRY	W.H.O
Temperature 20 <sup>0</sup> C		<40 <sup>0</sup> C <sup>a</sup>	<40 <sup>0</sup> c <sup>a</sup>	N.S
PH	5.93	8 - 9	6 - 9	7.0-8.5
Suspended Solids (mgll)	170	15	30	N.S
Dissolved Solids (mgll)	300	N.S	2000	N.S
Calcium (mgll)	184	N.S	200	75
Phosphates (mgll)	74.6	3	5	N.S
Flurine	-	1	N.S	1.0-1.7

### NOTE:

a) Within15m of outfall

b) depending on temperature N.S - Not specified.

_		momat	COLIDS	TN	100ML	SAMPLE.
PRSITTS	FOR	TOTAL	SOLIDS	TIN	TOOL	Drunt Line

SAMPLE WEIGHT OF CRICIBLE ( <b>G</b> )		WEIGHT CRUCIBLE 100ML(EVAP)(g)	NET WEIGHT (Total Solids- Present)(g <b>l</b> .
A	85.311	85.507	0.096
В	87.094	87.141	0.047
С	88.980	89.082	0.102
			<u> </u>

For Dissolved soilds in 100ml of sample.

WEIGHT OF (g)	WEIGHT CRUCIBLE 100ml )(EVAP)(g)	NET WEIGHT (Dissolved Solids) (9)
89.183	89.245	0.062
86.533	86.563	0.030
101.093	101.151	0.058
	WEIGHT OF (g) 89.183 86.533 101.093	WEIGHT OF (g) WEIGHT CRUCIBLE 100ml)(EVAP)(g) 89.183 89.245 86.533 86.563 101.093 101.151

SUSPENDED SOLIDS IN 100ML SAMPLE

SAMPLE	TOTAL SOLIDS - DISSOLVED SOLIDS (g)
Upstream	(A - A') -> 0.034
Effluent Discharge	(B - B') -> 0.017
Downstream	(C - C') -> 0.044

A = Upstream

B = Effluent Dischage

c = Downstream

Results in g/l	:	Suspended Solids (g/l)	:	Dissolved Solids (g/l)
 A	:	340	:	620
В	:	170	:	300
С	:	440	:	580

### APPENDIX B

STANDARDS STIPULATED BY. FEPA

### TABLE 3

NATIONAL EFFLUENT LIMITATION AND GASEOUS EMISSIONS GUILDELINES IN NIGERIA FOR SPECIFIC INDUSTRIES.

osphate fertilizer (Problems) osum sludge id wast-water gh Fluorine gh phosphate .rogenous Fertilizer milar Problems)	Maximum concen allowed for di into inland wa Effluent mg/l Suspended Soli Phosphate (PQ 3 Fluorine (F) PH -(8 - 9)	tration scharge(w ters. ds - 15 -) -3 -1
osum sludge id wast-water gh Fluorine gh phosphate .rogenous Fertilizer .milar Problems)	Effluent mg/l Suspended Soli Phosphate (PQ <sub>4</sub> 3 Fluorine (F) PH -(8 - 9)	ds - 15 -) -3 -1
osum sludge id wast-water gh Fluorine gh phosphate .rogenous Fertilizer .milar Problems)	Suspended Soli Phosphate (PQ <sub>4</sub> 3 Fluorine (F) PH -(8 - 9)	ds - 15 -) -3 -1
rogenous Fertilizer milar Problems)	Fluorine (F) PH -(8 - 9)	-1
rogenous Fertilizer milar Problems)	PH -(8 - 9)	
rogenous Fertilizer milar Problems)		
	Free ammonia - (as NH+ 4) Arsenic (as As) PH - 6 - 9 NO3 - 20	0.1
a Fertilizer milar Problem)	Ammonia as (N) PH -(6 -9)	- 0.6
licides	Total Pesticide	s - 0.1
culate mater from ding and mixing rines, ammonia ur, pesticulate ur	Particulate 100 Fluorine 9.0 Ammonia 3.0 Total 100	) 500 )
volume gypsum fertilizer facture		
	volume gypsum fertilizer facture	volume gypsum facture

Automative Battery		Total Suspended solids 28.
(Waste- Water)	Acid waste water	Oil and gas       - 10         PH       6 - 9         Iron       0.2         Cadmium       0.01         Nickel       0.05         Copper       0,06         Lead       0.01         Cabalt       0.5         Arsemic       0.1
Gaseous Emission	Lead Partculate	
Solid wastes	Defective lead plates	
Brewery	Alkaline effluent, high suspended solids	Suspended solids - 15 BOD <sub>5</sub> - 30
Waste Waters	High BOD	PH - 6 -9
(Solid Waste)	High COD Spent grain, defective packaging materials and labels, broken bottles.	C OD - 80
Dystuff and Dye	Colour effluent	Suspended solids
Intermed- inates.	High Suspended solids	

### TABLE 4

INTTERIM	EFFLUENT	LIMITATION	GUILDELINES	IN	NIGERIA	FOR	ALL
CATEGORIE	S OF INDUS	TRIES.					

PARAMETERS	LIMIT FOR DISCHAGE INTO SURFACE WATER (MGLL).	LIMIT FOR LAND APPLICATION (MGLL)
Temperature	< 400 within 15m of outfall	< 40oC
Colour (Loribund units)		_
РН	6 - 9	6 - 9
BOD5 at 20oC	50	500
Total suspended solids	30	-
Total dissolved solids	2000	2000
Chloride (as CL-)	600	600
Sulphate(as 502-4)	500	1000
Sulphide(as 52-)	0.2	_
Cyanide(as Cn=)	0.1	-
Detergents (Lab Sulphospahte as methylen blue active substance)	0.15	15
Oil and Gases	10	30
Nitrate as (NO-3)	20	-
Phosphate as(PO3-4)	5	10
Arsenic (as AS)	0.1	-
	ĺ	

- ..

	1	_
Iron (as Fe)	20	-
manganese(asMn)	5	-
Phenolic compounds (as Phenol)	0.2	-
Chlorine (free)	1.0	-
Chromium (Trivalent & hexavalent)	<1	-
Cadmium	<1	-
Copper	<1	-
Lead	<1	-
Mercury	<1	-
Nickel	<1	-
Silver	0.1	-
Zinc	3	-
Total metals	200	-
Calcium (as Ca2+)	200	-
Magnesium (as mg2+)	5	5
Boron (as mg 2+)	not detectable	Not detectable
Alktl mercury compounds	<0.003	0.003
Polychlorinated Biphenyls	<0.01	<0.01
Pestiacides (total)		-
Alpha emitters Nc/ml	107	-
Beta emitters NC/ml	10-6	_
Coliforms daily average	400mpN/100ml	500mpN/100ml
	1	1

### APPENDIX C

PROCEDURES FOR ALL CHEMICAL ANALYSIS AND PHYSICAL DETERMINATIONS.

# TOTAL DISSOLVED AND SUSPENDED SOLIDS DETERMINATION.

Analytically the total solid content of a waste water is defined as all the matter that remains as residue upon evaporation at  $103 - 105^{\circ}$ c, matter that has a significant vapor pressure at this temperature is lost during evaporation and is not defined as a solid.

### TOTAL SOLIDS DETERMINATION.

### APPARATUS.

- 3 glass crucibles
- Steam bath
- Oven dryer
- Filter Paper
- Analytical weight balance

### PROCEDURE.

- Weigh 3 glass crucibles
- Pipette 100ml of sample A,B and C into each of the crucibles and place in steam bath to complete evaporation.
- Transfer to the oven dryer at 194  $105^{0}$ c for further drying remove and put in desiccator to cool and then reweigh to set the net weight of the mass of total solids present on 100ml.

### TOTAL DISSOLVED SOLIDS

### PROCEDURE.

- Weigh 3 glass crucibles and label A, B and C
- Pipette 100ml of each sample of A, B and C and filter through a filter paper into the labelled crucibles.
- Place and evaporate to dryness air the steam bath and transfer to the oven dryer (at 103 105 oc) for further drying.
- Remove, place in a desiccator to cool and reweigh. The net weight is recorded as the mass of total dissolved solids.

#### TOTAL SUSPENDED SOLIDS.

The difference in the weight between the total solids and total dissolved solids gives the total suspended solids.

# DETERMINATION OF PHOSPHATE (IN ORGANIC PHOSPHATE.).

### APPARATUS.

- 100ml volume flask
- Beaker and graduated cylinder
- Filter paper (whatman No. 42)
- Test tubes
- Colorimeter

### REAGENTS.

- Trichloroacetic acid 5g/100ml. Place 50g of trichloroacetic acid, AR into a 100ml volume flask, dissolved in and fill to the mark with deionized water.
- 2. Sulfuric acid, 5mol/l slowly add 300ml of cone  $H_2SO_4$  AR to 750ml of deionized water, mix well and cool.
- 3. Molybdate reagent. Dissolve 25g of ammonium molybdate AR in about 200ml of deionized water into a one litre volume flask place 300ml of 5 molar  $H_2SO_4$  add the molybdate solution, dilute with washings to one lite with deionized water and mix solution is stable undefintely. Discard reagents if blanks show a blue color.

- 4. Sodium bisulfite, 15g/100ml. Place 30g of sodium bisulfite, AR into a beaker and dilute to 200ml with deionized water from a graduated cylinder, stir to dissolve, if the solution is turbid allow to stand well stoppered after several days and then filter. Keep reagent well stoppered.
- 5. Sodium sulfite. 20g/100ml. Dissolved 20g of sodium sulfite (anhydrous) AR in deionized water and dilute to the 100ml mark. Filter if necessary and keep well stoppered.
- 6. Aminoaphthol sulfonic acid reagent place 195ml of sodium buscufite solution (15g/100ml) into a glass - stoppered cylinder or other suitable container. Add 0.5g 1,2,4 aminoaphthol sulfonic acid and 5ml of sodium sulfite, 20g/100ml stopper and shake until the power is dissolved. If solution is not complete add water continuous solution is complete. Avoid excess of sodium sulfite. Transfer the solution to a brown glass bottle and store in the cold. It is stable for about a month.
- 7. Stock standard, 0.4mg phosphorus in 5ml (2.61 mol p/l). Place exactly 0.351g of dry potassium dihydrogen phosphate AR into a one litre volume flask, dissolved in deionized water, add 10ml of 5 molar H2504 and dilute to the mark with deionized water.
- 8. Working standard, 0.004mg/ml. Place 5.00ml of the stock phosphate into a 100ml volume flask and make up to the volume with trichloroacetic acid (5g/100ml).

### PROCEDURE.

- 1. Place 0.5ml of the solution (to be tested) into a 15  $\times$  50ml tube or a 10ml glass stoppered cylinder.
- 2. Blow in a 5ml of trichloroacetic acid (5g/100ml) mix and let stand for 5 minutes.
- 3. Centrifuge or filter through whatman No. 42 filter paper.
- 4. Pipette 2.5ml of clear filter into a test tube. Make up the missing volume with trichloroacetic acid (5g/100ml).
- 5. Add 1ml of molbdrate reagent to all test-tubes.
- Dilute to the 0.4ml of aminoaphthol sulfonic acid reagent; mix.
- Dilute to the 10ml mark with deionized water, mix and let stand for 5 minutes.
- Set blank at 100 percent T or zero A and read standard and unknown at 690nm wavelength.

### CALCULATION.

```
Where 0.02 = mg P contained on 5ml of working standard.
      10 = amount of filtrate prepared.
      2.5 = amount of filtrate used.
      100 = basic of expression of concentration
      0.5 = amount of sample. used
CALCULATION.
EG. FOR SAMPLE A (UPSTREAM)
Total solids in 100ml = 0.096
Total dissolved solids in 100ml = 0.062
Suspended solids in 100ml = (0.096 - 0.062)g
                          = 0.034g in 100ml
                          -> in mg/l = 0.034 x 1000
                                       ----- =340mg11
                                         0.1
RESULT (PHOSPHATE DETERMINATION)
For A \rightarrow absorbance unknown AU = 0.118
         Absorbance of standard AS = 0.414
```

mgp/100ml	=	0.188				10		100
		<b>-</b>	х	0.02	x		x	<b>-</b> -
		0.414				2.5		0.5

= 4.56mg/100ml Or 45.6mg**[**1

<pre>where 0.02=mgp contained in 5ml of working standard. 10= amount of filtrate prepared 2.5 amount of filtrate used. For B -&gt; absorbance of unknown = 0.913 100 basic of expressing concentration Absorbance of standard = 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100</pre>
Smil of Working standard.10= amount of filtrate prepared2.5 amount of filtrate used.For B -> absorbance ofunknown = 0.913100 basic of expressing concentrationAbsorbance of standard= 0.4140.5 = amount of sample used.mgp/100ml = AU101010
10= amount of filtrate prepared 2.5 amount of filtrate used.For B -> absorbance of unknown = 0.913100 basic of expressing concentrationAbsorbance of standard = 0.4140.5 = amount of sample used.mgp/100ml = AU10100
2.5 amount of filtrate used. For B -> absorbance of unknown = 0.913 100 basic of expressing concentration Absorbance of standard = 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100
For B -> absorbance of unknown = 0.913 100 basic of expressing concentration Absorbance of standard = 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100
<pre>unknown = 0.913 100 basic of expressing concentration Absorbance of standard = 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100</pre>
Absorbance of standard = 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100
Absorbance of standard = 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100
= 0.414 0.5 = amount of sample used. mgp/100ml = AU 10 100
mgp/100ml = AU 10 100
mgp/100ml = AU 10 100
mgp/100ml = AU 10 100
X 0.02 X X
AS 2.5 0.5
= 0.193
$ \times 16 - 7.46$
0 414
0.414
le 7.46 mgp/100ml or 74.mg/1
For C -> Absorbance of unknown = $0.109$
absorbance of standard = $0.414$
= AU 0.107
X 16 = X 16 = 4.14
AS 0.414
ie $4.14 mg/100 ml$ or $41.4 mg/1$ .

# CALCIUM DETERMINATION (as CaCO3/Calcium Hardness)

### APPARATUS.

- Conical flask
- Burette
- Beakers
- 250ml graduated flask.

### REAGENTS

- 1. Standard 0.1m EDTA
- 2. NH3/NH4cl pH 10 Buffer solution
- 3. Eriochrome Black T indicator.

### PROCEDURE.

To a 50cm3 sample of water to be tested add 1cm buffer solution (ag NH3/NH4cl) and 30 - 40 mg Eriochrome black T indicator Titrate with standard 0.01m EDTA solution until the color changes from red to pure blue.

The value is expressed in part of  $c_a co_3$  per million of water (total hardness).

RESULT	А	В	С
Final Reading (ml)	6.30	9.20	7.20
Initial Reading(ml)	0.00	0.00	0.00
Net volume(ml)	6.30	9.20	7.20

### CALCULATION.

 $1ml of 1m EDTA = 100MG OF C_aCO_3$ 6.30ml of 0.01m EDTA =  $1 - x 6.30 \times 0.01$ -> 6.30mg of  $C_aCO_3$  Where 100=mass of  $C_aCO_3$ Calcium hardness present in 50ml of water sample A = 6.3-mg in one litre =  $6.30 \times 1000$ --- = 12650 = 126mg of  $C_a CO_3$ or 1267 ppm For  $B = 100 \times 920 \times 0.01 = 9.2 \text{mg } C_a CO_3 \text{ in 50ml}$ in one litre = 9.2 x 1000 = 184 mg/ml or 184 ppm of  $C_a CO_3$ For C -> 7.2 x 100 x 0.01 = 7.2mg of  $C_aCO_3$  in 50ml Sample in one ---50 litre = 7.2 x 1000 =  $144 \text{mg/l} \text{ C}_a \text{CO}_3$  or 144 ppm of  $\text{C}_a \text{CO}_3$ -----50

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