EVALUATION OF EFFECTIVENESS OF FILTRATION UNIT OF MINNA WATER TREATMENT PLANT

BY

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97/6061 EH

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A RESEARCH PROJECT REPORT SUMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

IN PARTUAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN CHEMICAL ENGINEERING

OCTOBER, 2003.

DEDICATION

First off, I'd like to give praise and thanks to God, the most Gracious. This work is dedicated to my mother Hajiaya Mulikat Mohammed. Thanks and true respect to everybody who was involved in making my whole life worthy living and making the time for us to put our minds together to lace things right, I love you all. Last and certainly not the least much appreciation to All Da Bross, thanks for listening and supporting. To everyone who watch me grow, Ali-Balogun S.B thanks for believing in me to give me such an incredible support, God bless, Amen.

ACKNOWLEDGMENT

Praise is to God the Almighty, the beginning and the end. Thanks for seeing me through the university activities and believing accomplishment was by your knowledge. The knowledge in know you never stop learning, I always count on you.

I will want to give my sincere appreciation to my project supervisor for your support and kindness, .you're entirely different a person, may God see you through, Amen.

Eng. Aliyu Jagaba of Minna water board and Eng. Aliyu Jipo thanks for your support. Isah Mohammed, Mohammed Rabiu, General, Sherifat Bola and all my friend as a whole thank for your individual support and respect, may God help and see us through, Amen.

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DECLARATION

I hereby declare that the research and the project work was written by me, that it is a record of my own research and project work. Information are derived from experiment carried out, published and unpublished work of others are specifically acknowledged by means of references.

31-10-03

STUNDENT

DATE

MOHAMMED ABDULRASHEED

ABSTRACT

Safe drinking-water is one of the corner-stones of primary health care, yet contamination with various pathogens and a multitude of chemical is a worldwide problem. Filtration is one of the main processes of water treatment which makes it possible to improve the quality of water to the standard of potable water which reduces the exposure of the populace to hazardous effect of unsafe water.

The experimental analysis revealed that the water supplied to the populace from the old treatment plant (Bi-water) is as good as not filtered .The Minna treated water was analyzed before filtration and after passing through the filtration plant, which revealed that there was no remarkable difference between the water samples before filter and after been filtered in the old treatment plant (Bi-water), and the new treatment plant (Impresit) shows its effectiveness when analyzed before and after the filtration process of some major water parameters such as turbidity, odour, iron, sulphate, conductivity and dissolved oxygen, and compared to the world health organization water quality standard. The high nitrate concentration which was observed may be due to the improper application of the water treatment procedure or disinfectant by-products.

To improve on the quality of filtered water, therefore the new treatment plant should be properly maintained and adequate evaluation of the effectiveness of the plant in other to know the quantity of the disinfectant and treatment procedure to use. And for the old filtration plant another filtration unit is needed and should be obtain from the major types of designed filtration unit available to increase water supply to the Minna environ and to reduce the danger of potable water to the safest minimal.

APPROVAL PAGE

This project has been read and approved as meeting the requirement of the Department of chemical Engineering in the school of Engineering and Engineering Technology, Federal University of Technology, Minna, for the award of Bachelor of Engineering (B.Eng.) Degree in Chemical Engineering.

21/10/03.

ENG. ABDULAZEEZ, O. S. DATE

(PROJECT SUPERVISOR)

DR. F ABERUAGBA DATE

EXTERNAL EXAMINER DATE

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CHAPTER ONE

1.0 INTRODUCTION

Water treatment processes can not be controlled effectively unless the operator has some means to check and evaluate the quality of water been treated.

For the past years, Minna treatment plant has being facing series of questions by the consumers on the quality of water, the consumers relies principally upon his or her sense. Water constituents may affect the appearance, odor or test of the water and the consumers will evaluate the quality and acceptability of the water on basis of these criteria. Water that is highly turbid is highly coloured, or has an objectionable taste or dour may be regarded by consumers as unsafe and may be rejected for drinking purpose.

Water is essential to sustain life, and satisfactory supply must be made available to consumers. Every effort should be made to achieve a drinking –water quality as high as practicable. Protection of water supplies from contamination is the first line of defence. Source protection is almost invariably the best method of ensuring safe drinking-water and is to be preferred to treating a contaminated water supply to render it suitable for consumption. Once a potentially hazardous situation has been recognized, however, the risk to health, the availability of suitable remedial measures must be considered so that a decision can be made about the acceptability of supply. As far as the evaluation of the effectiveness of the water treatment plant is always measured and achieved, the water supplied will be protected from contamination by human and animal waste, which contain a variety of bacteria, viral and protozoan and helminth parasite which could cause an advanced effect on man and animal. Failure to provide adequate effectiveness of the plant will hinder the corresponding protection and treatment require, which will expose the community to the risk and outbreak of intestine_and other infectious diseases.

It should be noted that the use of chemical disinfectant in water treatment usually result in the formation of chemical by-product, some of which are potential hazardous. Therefore more attention must be focused on the filtration water treatment unit, since filtration is one of the main processes of water treatment which makes it possible to improve the quality of water to the standard of potable water. To evaluate the effectiveness of the filtration chamber (unit) many parameters such as physical parameters like colour, turbidity, conductivity, taste, odour, total dissolved solid suspended ,ph, particles etc and chemical parameters like iron, sulphate, nitrate, lead, silicon, copper, manganese, fluoride etc, must be taken in to consideration in the assessment of water quality, based on the standard and guidelines of Environmental Protection Agency (EPA) and World Health Organization (WHO) quality water standard and guidelines.

1.1 AIM OF WORK

The evaluation of effectiveness of the filtration unit of Minna water treatment plants

1.~~1~~2 OBJECTIVE AND SCOPE OF WORK

The objective and scope of the research work are: To evaluate the performance of the filtration unit of Minna water treatment plant by studying the chemical and physical parameter in a way to improve the quality of water produce from Minna treatment plan ,in order to control the risk on water that is below or above the permissible limit of world Health Organization (WHO) standard and to determine how the system or treatment should be regulated or monitored to achieve an optimum quality and quality.

The limitations of the research are that the results obtained from experimental analyses are compared with the World Health Organization and Environmental Protection Agency water quality standard.

CHAPTER TWO

2.0 LITERATURE REVIEW

Water is essential for life and plays a vital role in the proper function of the earth's ecosystems. The pollution of water has serious impacts on all living creatures, and can negatively affect the use of water for drinking, household needs, recreation, fishing, transportation and commerce. Environmental Protection Agency (EPA) enforce federal clean water and safe drinking water laws, provide support for municipal waste water treatment plant, and takes part in pollution prevention effort aimed at protection watersheds and sources of drinking water.

The principal objective of water treatment is not to obtain pure water but to obtain treated water which consists of some basic element that is within the acceptable limits of Environmental Protection Agency (EPA) and World Health Organization (WHO) water standard and it is said to be clean, pure or potable water.

It is worthy of note that since the basic objective of chemical engineering is to convert raw materials to required product using scientific and engineering principles . The evaluation of the effectiveness of the filtration unite is to produce potable water which is ensure by series of laboratory test, that provides necessary information to monitor the treatment processes and ensure a safe and non-tasty drinking water by the consumers. By matching and relating the laboratory result with the WHO and EPA guidelines values and standard of quality water and water obtained from filtration exercise, enable the operator to select the most effective operation procedure, determined the efficiency and effectiveness of the treatment processes and identify the potential problems and provide the necessary adjustment before they cause significant effect on the finished water quality.

2.1 BRIEF HISTORY OF THE ORGANIZATION

Upon the creation of Niger State from the North Western state in 1976, the Niger State and sanitation board, now Niger State water board was established to supply potable drinking water for the inhabitant of the state. The board, through its water treatment plant was established to undertake the storage of raw treatment and distribution of treated water to the consuming public.

2.1.1 CHANCHAGA WATER TREATMENT PLANT

The Chanchaga water treatment plant is situated along Minna Suleja-Abuja road in Chanchaga town. It supplies water to Minna metropolis and its environs. The intake point is the Chanchaga River while Tagwai dam 10 kilometers away from Chanchaga town, serve as source.

The Chanchaga water works has two main treatment plants. The old treatment plant constructed by Bi-water in 1976 with a treated water capacity of $350m^3/hr$ and the new treatment plant constructed by Impresting in 1995 with a treated water capacity of $3,500m^3/hr$.

2.1.2 SOURCE OF WATER

The source of water in Minna, Niger State is the Rainfall. The climate of the town is a resemblance of tropical region of the world. The major wind disease is normally along south-west and north-east axis. The raining season last between 180-200days (6-7 month) while about 1350mm (54inches) with September recording the height rain of 300mm (11.7 inches) .Monthly temperature is height in march at 37^0C (88^0f) and lowest in August at 27^0C (75^0f).

During the winter the Tagwai dam serves as the source of water which enhances the supply of water to the community during this period.

2.2 WATER CHARACTERISTICS

CHEMICAL AND PHYSICAL PARAMETERS

i. pH

It is an index of hydrogen ion concentration. It may be acidic, neutral or alkaline.

ACID: The PH range 1-7 is caused by an or a chemical reagent with acid characteristic.

NEUTRAL: PH values of 7

ALKALINE: The PH range 7-14 is caused by an alkaline or chemical reagent with similar reaction.

ii. DRY RESIDUAL

It is the content of solid substance in a determine volume of water after evaporation at 105, 180, or 600^0C. It is an index of the composition of water and of its salinity. It is expressed in g/l.

iii. SUSPENDED SOLID AND SETTING SOLIDS

Both values give an indicator about the content of the solid substances not dissolve in water but in it as separated bodies. They are expressed respectively in mg/l and in ml/l

iv. KUBEL INDEX

This give global expression of the content of organic matter in the water. It is expressed in mg/l of oxygen (0_2).

v. DISSOLVED OXYGEN

It expresses the quantity of oxygen dissolved in the water at a certain temperature. It is an index of water at purity. It is expressed in mg/l of oxygen (0_2)

vi NITROGEN

It is determined as ammoniac nitrogen, nitrites and nitrates.
It is an index of possible water pollution by sewage waters, fertilizer or decomposing organic matter. Nitrate content up to the maximum permissible level in force in Nigeria is allowed, while nitrite and ammoniac nitrogen is totally eliminated.

vii HARDNESS

It is distinguished in
carbonate hardness
non-carbonate hardness
Total hardness
Hardness is the quantity of calcium and magnesium salts present in water. It is expressed in ppm of $caco_3$ or in French degree (^{0}f) one of is equal to 10ppm of $caco_3$.For example, water with 70ppm of $caco_3$ has a hardness of 7^0f. Carbonate hardness is due to the calcium and magnesium. Non-carbonate salts as chloride and sulphates. Total hardness is determined as the sum of the two above described qualities.

viii ALKALINE

It corresponds to the sum of the contents of bicarbonates, carbonate and hydrates. It is expressed as ppm of $caco_3$ or ml of HCl 0.1m.

Other chemical determination for examples sulphate, chlorides, calcium, magnesium, and so on, may be affected in order to determine water salinity.

Determination of sulphide, phenols, magnesium, iron and other toxic element are useful for the most suitable water treatment process and present cases of poisoning or their damages to the potable water consumes.

The bacteriological investigation determined the content of bacteria in the tested water after culture or agar pre-determined time at various temperatures.

The content of bacteria is expressed as the number of micro-organism in 100ml. General coliform bacteria are investigated particularly escherichia coli, which indicate the presence of water pollution by Fecal matter.

The data obtained by bacteriological investigation are very important, only bacteriological potable water may be fed by the costumers.

2.3 CHARACTERISTIC OF TREATED WATER

The standard quality reached at the end of the treatment process, will be according to the requirement, and according to the standards recommended by the World Health Organization. The maximal permissible levels are summarized in the table below.

TABLE 2.3 WHO. GUIDELINES FOR INORGANIC AND AESTHETIC QUALITY OF WATER FOR HEALTH SIGNIFICANCE IN MG/LITRE

CHEMICAL CONSTITUENT	PERMISSIBLE LIMIT	EXCESSIVE LIMIT	MAXIMUM ALLOWABLE LIMIT
Arsenic	0.05	--	0.2
Asbestos	no guidelines values	--	--
Barium	no guidelines values	--	--
Beryllium	no guidelines values s	--	--
Cadmium	0.005	--	--
Chloride	200	400	0.05
Chromium	0.05	--	--
Cyanide	0.1	--	--
Fluoride	1.5	--	--
Zinc	5.0	902	--
Ph	6.5-8.5	--	--
Detergent	no guidelines, there	Should be no foaming	Tested or odor problem
Lead	0.05	--	0.1
Mercury	0.001	--	--
Potassium	20.0	100.0	--
Sodium	200.0	--	--
Calcium	75.0	200.0	--
Magnesium	50.0	150.0	--
Nitrate	10.0	45.0	--
Nickel	--	--	--
Selenium	0.01	1.5	--
Aluminum	0.2	1.0	--
Copper	1.0	1.50	--
Iron	0.3	1.0	--
Manganese	0.1	0.5	--
Solid, Total solid	1,000	--	--
Sulphate	4,000	preferable less than One for disinfection efficiency	

TABLE 2.4 WHO GUIDE VALUES FOR PHYSICAL, CHEMICAL AND BACTERIOLOGICAL PARAMETERS

SUBSTANCE OF PROPERTY	WHO GUIDE LEVEL STANDARD	WHO MAXIMUM ADMISSIBLE CONCENTRATION
Nitrate	10mg/l	--
Total suspended solid	Nil	--
Colour	15Tcu	50Tcu
Turbidity	5Ntu	25NTu
Taste	Unobjectionable	--
Odour	Unobjectionable	--
Iron	0.3mg/l	1.0mg/l
Manganese	0.1mg/l	0.5
Magnesium	50mg/l	150mg/l
Sulphate	250mg/l	100mg/l
Chloride	25mg/l	60mg/l
Ph range	6.5-8.5	Less than 6.5 or greater than 9.2
Conductivity	100us/cm	1500us/cm
Total hardness	100mg/$caco_3$	500mg/l $caco_3$
Fluoride	1.5mg/l	1.7
Total dissolve solid	1000mg/l	1500mg/l
Coli from bacteria		
Number per 100m	0.3	--
E-coli	Nil	Nil

TABLE 2.5 GUIDELINES TO DISINFECTANT

DISINFECTANT	GUIDELINES VALUES (MG/L)	REMARK
Monochlorominede and trichloramine	3	NAD
Chlorine	5	ATO For effective disinfection there should be a residual concentration of free chlorine of 0.5 after at least 30 minute contact time PH<8.0
Chlorine dioxide		A guideline value has not been established because of the rapid breakdown of chlorine dioxide and because of the chloride guideline value is adequate protected for potential toxicity from chlorine dioxide
Iodine		NAD

TABLE 2.5 GUIDELINES FOR DISINFECTION BY-PRODUCT

DISINFECTION BY-PRODUCT	GUIDELINES VALUES (mg/liter)	REMARK
Bromate	25h(P)	For $7*10^{-5}$ excess risk NAD
Chlorate		
Chloride		
Chlorophenols	200(P)	
2-chlorophenols		NAD
2,4-dichlorophenols		NAD
2,4,6-frichlorophenols	200b	For excess risk of 10^{-5} ATO
Formaldylyde	900	
MX		NAD
Trihalomethaanes		The sum of the ratio of the concentra of each to its respect guideline va should not exceed 1
Biomoform	100	
Dibromochloromethane	100	
Biamodichloromethane	60b	For excess risk of 10^{-5}
Chloform	200	
Chlomatid acitic		
Acids		
Monochloroacetic		
Dichloro acetic acid	50(P)	
Trichloroacetic	100(P)	
Chloral hydrate	10(P)	
Chloro acetone		NAD
Chloropicrin	70	NAD
Cyanogens chloride	90(P)	
Dichloro acetone nitrate		
Halogenated		

2.4 PROCESSES INVOLVED IN THE WATER TREATMENT PLANT

2.4 PROCESSES INVOLVED IN THE WATER TREATMENT PLANT

Source protection is almost invariably the best and safest method of ensuring safe drinking-water and is to be preferred to treating a contaminated water supply to render it suitable for consumption. May nations have water source protection and some nations do not have.

The water treatment processed comprises of different stages as described below but filtration is one of the main processes of water treatment which make it possible to improve the quality of water. The source (the rain water), water before filtration and after filtration (the product) was evaluated through laboratory analysis of the samples which gives the resulting effectiveness of such process and this result is to the operator, which compared with the standard values and enable an appropriate measure when necessary.

The result obtained is based on the general characteristics of the water and the process description or method involved in the water treatment.

2.4.1 PLANT DESCRIPTION

Distribution section

Coagulation section

Flocculation section

Sedimentation section

Chemical storage and dosage section

Filtration section

Gas chlorine dosage section

2.4.2 PROCESS DESCRIPTION

The main treatment phase are listed below

Inflowing flow-rate measurement

Distribution

Prechlorination

Coagulant addition and flash mixing

Ph control and lime addition

Coagulation and flocculation

Sedimentation

Rapid filtration by gravity through filter

Post-chlorination for disinfection

Measurement of final residual chlorine

Storage of filtered water from which service water and backwash water are taken.

The process of the treatment plant from the pipe conveying the raw water to the plant, a flometer of the magnetic type has been provided for measuring and recording the incoming flow rate. Moreover, it will permit the control of the chemical dosage

The raw water flows into a distribution chamber, which consist of a single tank with useful capacity of 13m3, the pre-chlorination is necessary to prevent a proliferation of algae in the tank. The pre-chlorination also prevent the equipment of algae, the chlorine is dosed proportionally into the in-coming raw water flow rate.

The raw water is the sub-divided in to two equal streams by means of two adjacent weirs, each one can be separated intercepted by a sluice gate.

At the distribution chamber outlet, the dosage of the coagulant (Aluminium sulphate) occurs interlinks with the discharges of the raw water, so as to have a dosage in proportion thereto.

Due to low salt content in the raw water, the dosage of aluminium sulphate causes considerable PH decrease and therefore, the addition of lime milk (which interconnected with pre-established PH values) is necessary to carry out the PH correction. For the latter, the PH measurement points have been envisaged at the flocculation tank inlets

The addition of the lime milk taken place in two flash mixers unites, while inlet. Afterwards, the water flows into two sedimentation tanks of upward flow type, each one provided with 60 lamellar packages. In such a type of sedimentation unit, an upward flow-rate of about 8m/hr is allowed at maximum expected flow-rate. The clarified water coming out from each sedimentation unite in to common channel and it is distributed between two filter group each consisting of rapids gravity filters. Each filter is equipped with a filtering layer monogranular siliceous hozzles. The backwashing, which is necessary for the filter regeneration, consists of two sub-sequent phases. The first phase is carried out air and the second one with water

Prechlorination together with flocculation and sedimentation followed by filtration through sand, achieve the elimination of the turgidity of iron and manganese, as well final disinfection achieved by using chlorine solution.

Post-chlorination and final disinfection with concentration of 0.3mg/l are conditions, which guarantee the complete elimination of all pathogens agent that might be present.

Filtered and chlorinated water is then conveyed to the clear water tanks (CWT) where from it can be used for the filter regeneration, the preparation of the chemical solution, as well as distribution to the treatment plant network area.

2.5 FILTRATION

Filtration is one of the main processes of water treatment which makes it possible to improve the quality of water to standard of potable water. Filtration can separate not only disperse particles, but also colloid from water. Processes used to remove non-settle able floc remaining after chemical coagulation and sedimentation. Filtration is the final stage of water treatment and is carried out after clarification in settle flitotor or clarifiers.

When water is passed through a layer of granular material, the kinds of filtration are possible, depending on the charge and the ratio between the sizes of water impurities and that of granulated particles of the filter filling.

(a) Retention of impurities on the surface of filtering bed (film filtration)

(b) Retention of impurities particles in pores of the filtering bed (volume filtration)

(c) Simultaneous formation of a film of impurities and deposition of impurities in pores of the filling.

The filtrations have been for seen in rapid gravity single media, constant flow rate variable level filter. Ten filters were provided corresponding to a total filtering surface of 360m^2. Each filter has the following feature

Length 9m

Total width 5m

Useful width 4m

Height of filtering layer 1m

Filtering surface 36m

The filtration speed is equal to 5.9m/hr at normal condition and 6.6m/hr when one filter is being cleaned. Each filter is fully disconnected without affecting the operation of the outer ones. In each filter pit, an outlet weir, 1m in length was provided and it is filtered with steel regulating blades, which are positioned in each a manner as to make each filter locating the same flow rate. During the filtration solid particles accumulate on the filtering layer and increase the head loss. The filtering layer is composed of quartz sand with particle size ranging from 0.8mm to 1.2mm and uniformity co-efficient of 1.8. The maximum allowable water head above the sand layer is equal to 2m.

Sluice gate with four sides seals electrically operated have been provided at each filter fit for the backward water discharge. The filtered water is collected into a pit by a short ND 250 branch, which is filtered with an electrically ND250 butterfly vales intercepting the filter during backwash. A weir is provided on the outlet of each well and the filtered water is collected in another well, of each well and the filtered water is collected in another well, common to a couple through a ND600 Dci pipe two 600 Dci pjpe conveying filtered water coming from five adjacent filter supply a common ND 100 header, which feeds filtered water to the clear water tank (cwt)

2.5.1 BACKWASHING

Filter backwashing has been for seen in two separate phases.

The first consist of air blows at a rate of 1800µm3/hr which correspond to a specific requirement of 50µm3/hr/µ. For each filter, one electrically operated ND 200 butterfly values allows the backwash air entering the filter. The bush water process is spilled from clean water tank by means of a µD500 header and each sucks through a µD500 pipes and discharge through a µD350 ,pipe into a µD400 header, which convey the water to the filters. A magnetic flow water has been provided in the µD400 pipe.

2.6 WATER QUALITY

Water quality is affected by some factors which causes the level of impurities in the natural raw water. Due to these impurities natural pure water does not occur. The degree of impurities varies and are contributed to the water either Natural such as

i. Storm water formed from surface run-off.
ii. Acidification of rain water.
iii. Dissolution under the ground.

And for artificial by animals or man's waste such as :

i. Industrial discharge.
ii. Sewage.
iii. Agricultural waste products such as pesticides, etc.

In addition the contamination by human and animals waste, which contain a variety of bacteria, Viral and protozoan and helminth parasite, leads to quality deterioration of the source (raw water).

Water treatment process depends on the use of the water on the type of analysis or parameters investigated. Water should meet different quality specification which shows how effective such plant and the treatment method applied.

The main objective of evaluating the effectiveness of the filtration unit is to determine how the system or treatment process should be regulated or monitored to achieve an optimum quality and quality water supply to meet different specifications. To achieve these series of laboratory test are carried out. The laboratory test commonly carried out includes:

i. Total dissolved solids (T.D.S)
ii. Turbidity
iii. PH
iv. Total hardness
v. Iron
vi. Sulphate
vii. Colour
viii. Nitrate
ix. Suspended particle

x. Silicon oxide
xi. Conductivity
xii. Temperature

2.7 USES OF WATER

2.7.1 WATER FOR DOMESTIC USAGE AND DRINKING.

The drinking standard established by WHO and EPA reflect the best available scientific and technical judgment by establishing achievable safe levels as maximum contaminant level goal for drinking water protect public health. Therefore drinking-water should be harmless to the health of man, have proper required properties ratio and be suitable for any kind of domestic use. In essence the water for consumption is expected to meet minimum level of standard guidelines as much as possible for protection of the public health. These water quality standards give information about suitability of water for public supply.

2.7.2 INDUSTRIAL USE

Water for food industries should satisfy additional requirement from those indicated, the proportion of some element may be reduce.

Water for breweries should be absolutely free from sulphates and contain not more than 0.1mg/l of iron, water for wine distilleries should be free from magnesium and calcium chlorides, water for sugar refining plant should be as low as possible in salts etc.

2.7.3 COOLING WATER

This is a process whereby particular water is used for the removal of high temperature heat from continuously operating plants or from products. Cooling water is used in direct flow scheme (that is it is discharge into the water basin upon single use) and in return and recirculation scheme. In this latter case, the heated water is cooled in cooling tower or spring ponds and is then re-used in the process.

The quality of cooling water is not specified since it depends on the particular condition at a point. It is clear, however that cooling water should form no deposit in tank and apparatus through which it flows water for cooling should contain no large mineral suspensions and be low in iron and organic matter in order to avoid dogging and biological scaling pipes of heat exchange condensers. In direct flow cooling system the formation of calcium carbonate scale is usually observed.

Therefore the quality of cooling water to avoid dogging of pipes and exchange and corrosion of metal depend on the particular condition and should be determine by special calculation which consider all the factors mentioned.

2.7.4 WATER FOR FLOODING OF PETROLEUM STRATA

The water used should be free from particles, that is, should cause no dogging of filter holes and voids of the oil-bearing rocks by insoluble compounds which might form on its later section with strata water and rocks particles or on temperature changes. For this reason infection water should contain not more than 0.2mg/l of iron, 1mg/l of suspended matters, 1g/l petroleum product etc.

2.7.5 WATER FOR STEAM POWER PLANT

This is the type of water use for the generation of electricity (power), and it is require forming no scale, no corrosion, not liable for foaming and promoting no carry off of salts and steam. The use of water can lead to scaling heating surface, which worsen the condition of heat transfer, increase the fuel consumption, cause metal over heating, and in the final result can lead to the formation of blisters and blow holes in pipes.

2.7.6 WATER FOR AGRICULTURE USE

This is the kind of water use for irrigation processes, poultry farm and animals rearing etc. Water should have the quality appropriate for particular application based on life of animals and plants. And for irrigation purpose, the salt content should be low where possible in order to avoid soil salinization which makes soil unsuitable for agriculture uses. Water with salt content up to 1g/l is suitable for irrigation irrespective of local soil condition.

CHAPTER THREE

3.0 EXPERIMENT ANALYSES

These are the method or processes for investigating and determine water parameters to evaluate the effectiveness of the filtration unite in Minna water treatment plant. Few litres of the raw water, water before and often filtration was taken were used as samples was for physical and chemical analysis. A separate volume each sample was collected and examine from both treatment plant (the same source (raw water) but different treatment plant).

3.1.0 APPARATUS USED

The equipments used are:

i.Direct heading spectrophotometer

ii.Conductivity/TDS meter

iii.Lovibond 2000 PH/meter

iv.incubator

FIG 3.1.0 DIRECT READING SPECTROPHOTOMETER

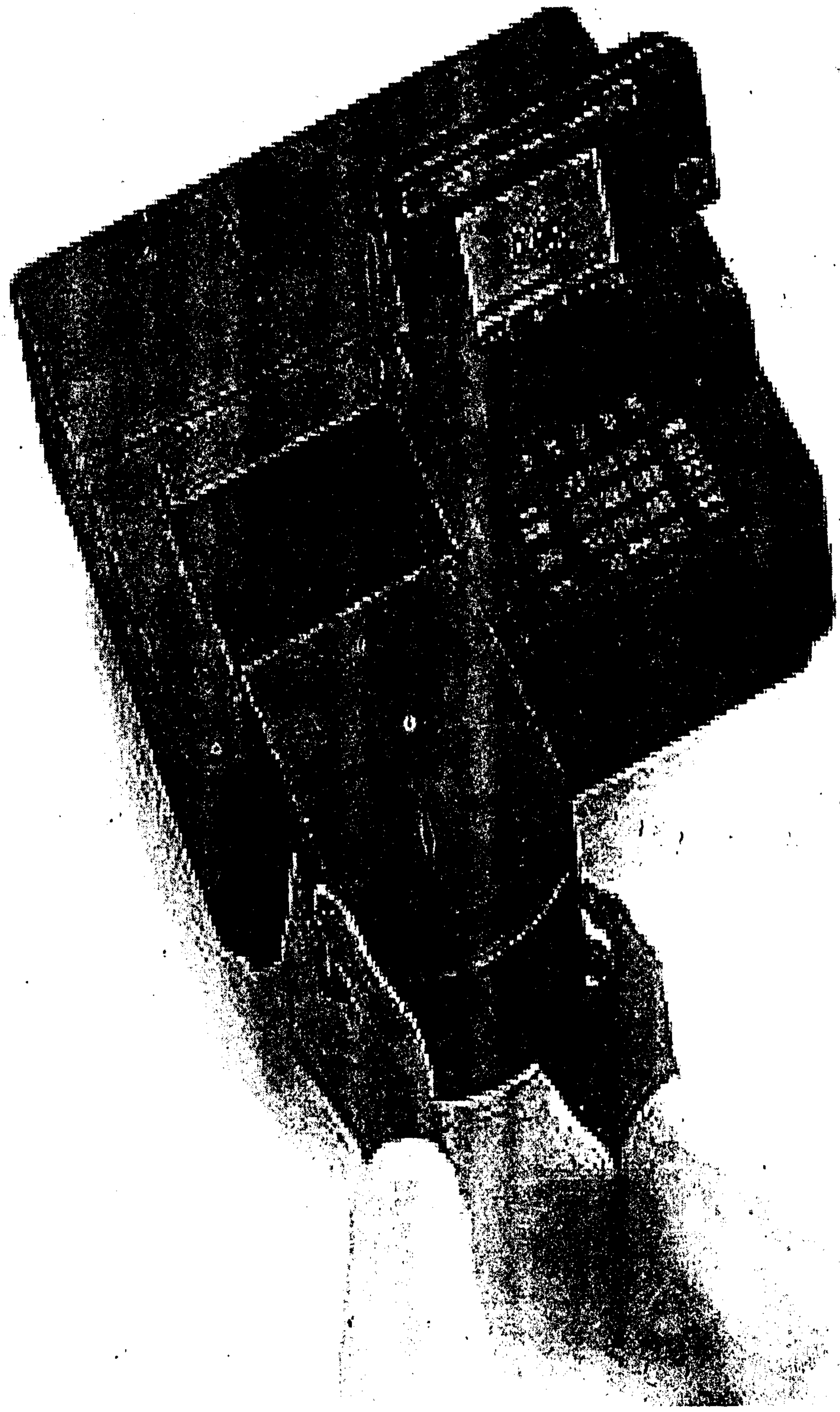
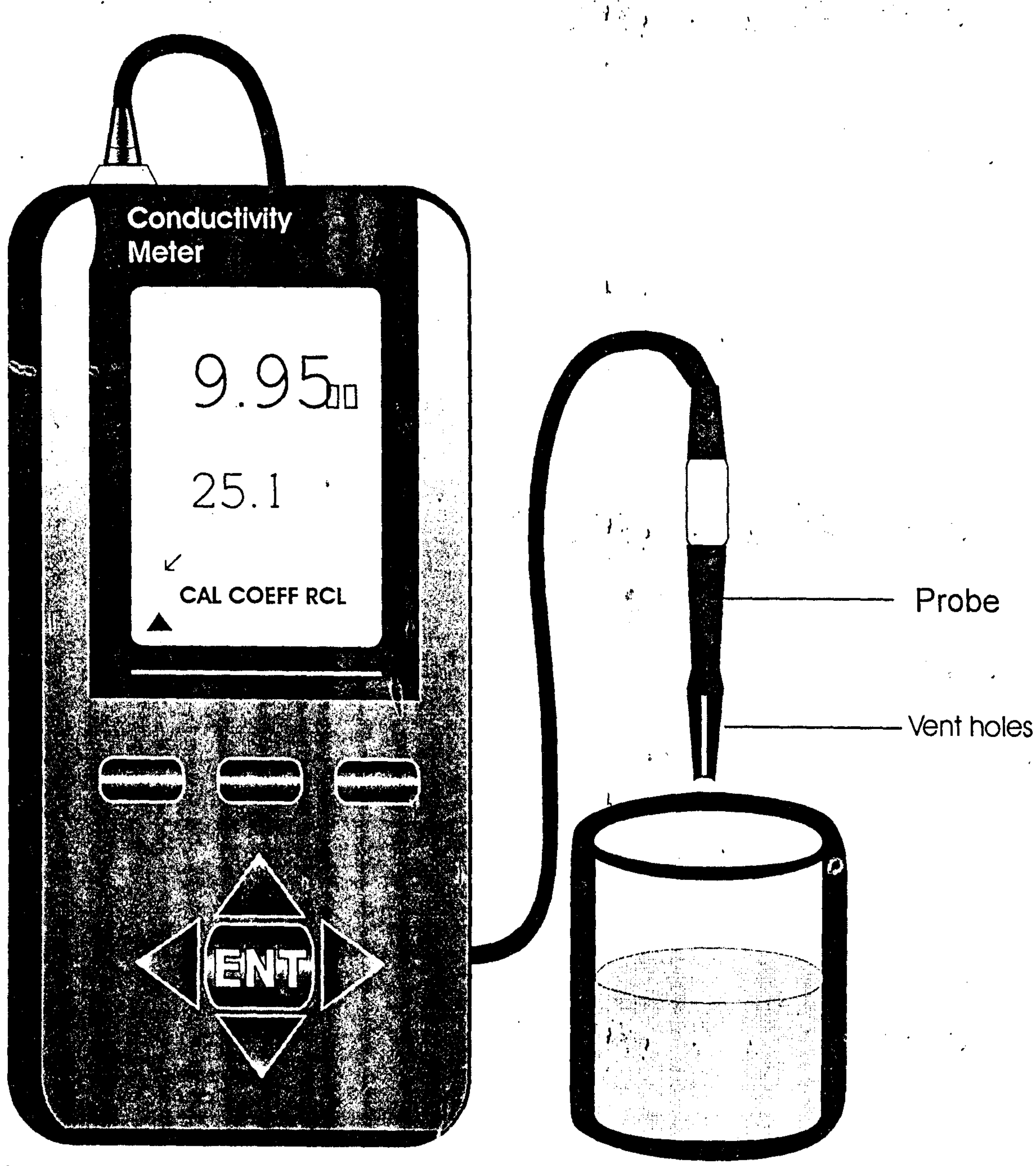
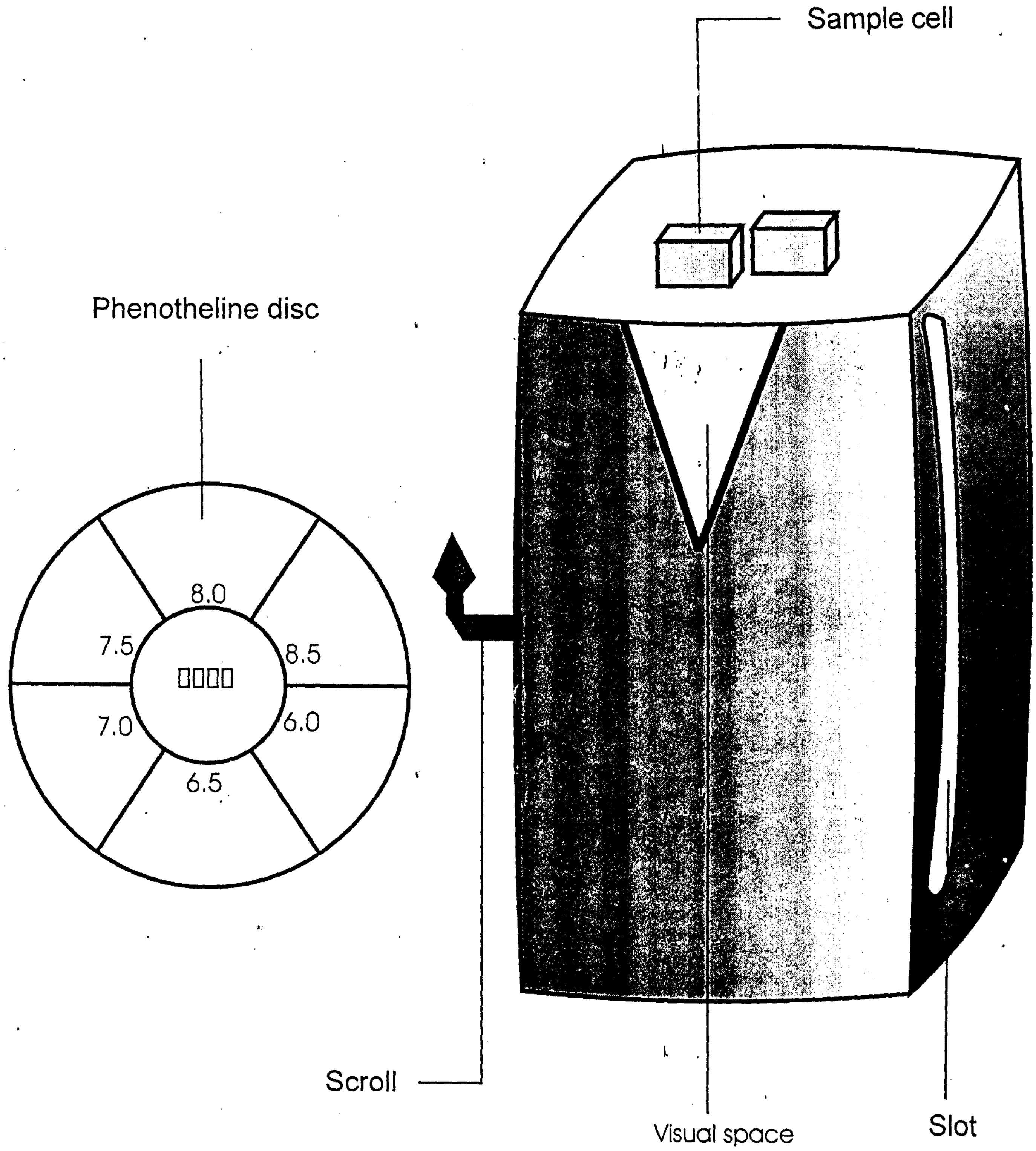


Figure 3.1.1



Conductivity/TDS meter

Figure 3.1.2



Lovibond 2000pH/meter

3.1 PHYSICAL PARAMETER AND CHEMICAL PARAMETER ANALYSES

3.1.1 TURBIDITY

Method used is called Attenuated Radiation Method (Direct Reading)

Summary of method

This test measure turbidity, which is an optical property of the sample that result from the scattering and absorption of light by particles in the sample. The amount of turbidity measured depends on the size, shape, colour and reflective properties of particles.

Experimental Procedure: Samples were collected into clean separate plastic bottles. The 50H trey under the HACH PROGRAMM of the spectrophotometer is pressed and the stored program number for turbidity in FTU was selected by pressing the numeric keys 3750 and was entered. HACH PROGRAM: 3750 Turbidity Absorb was displayed on the screen and the wavelength ( ) 860nm, was automatically selected immediately. A set of matched sample cells were used and one of clean sample cells was filled to 10ml with demonized water (the blank). The other matched sample cells was rinsed with sample and filled to 10ml mark with the sample (that was prepared sample). The sides of the sample cells were wipe with a clean soft cloth and a small amount of silicon oil was applied on the outside of the sample cells to minimized the effect of surface defect on the measurement. The blank was placed into the cell holder and the light shield was closed, the soft key under zero was pressed which displayed OFTU on the screen and the blank was gentle removed. The second sample (the prepared sample was inverted several times to mix and was immediately placed into the cell holder with the light shield closed. Results in FTU turbidity of the sample displayed on the screen and recorded.

3.1.2 SULPHATE

Method Used: Sulfa ver4 method

Summary of method

Sulphate ions in the sample react with barium in sulfa ver4 and form a precipitate of barium sulphate concentration. The sulfa ver4 also contain a stabilizing agent to hold the precipitate in suspension.

Experiment Procedure: The soft trey under the HACH PROGRAM of the spectrophotometer is pressed and the stored program number for sulphate (50_4^{2-}) 3450 with the numeric keys was entered. HACH PROGRAM 3450 sulphate was displayed on the screen and the water length ( ) 450nm was selected automatically. A clean sample cell filled with 25ml of sample and a content of one sulfa ver4 reagent power was added to the sample all (the prepared sample) and swilled to mix. The time was adjusted for 5 minute of reaction period. A second sample cell filled with 25ml of sample (the blank) which was placed into the cell holder immediately the time keeps (after 5 minute of reaction period). The soft trey under zero was pressed and 0.00mg/l 50_4^{2-} was displayed on the screen. The blank was removed and the prepared sample was placed into the cell holder with the light shield closed. Result in mg/l surface was displayed and noted.

3.1.3 ODOUR

This was done through the use of physical sense organ. (The nose).

3.1.4 TASTE

This was done by collecting the sample s quality in the mouth separately.

3.1.5 SILICA ($S1_{02}$)

Method Used: Hetetropoly Blue Method

Summary of method

Silica and phosphate in the sample react with molybdate ion under acidic condition to form yellow silicomolybdybdic acid complexes and phosphomolydbic acid complexes. Addition of citric acid destroys the phosphate complexes. An Amino acid is then added to reduce the yellow silicomolybdic acid to an intense blue colour, which is proportional to the silica concentration.

Experiment Procedure:

The soft key under the HACH PROGRAM of spectrophotometer was pressed and the stored program number for low range silica was selected by pressing 3360 minute keys and entered. The screen displays HACH PROGRAM: 3360 silica LR and the wavelength ( ) 815nm automatically selected. Two sample cells filled with 10ml of the sample each and 0.5ml of molybdate reagent was added to each sample cell and was swilled to mix.

The soft key under the time was pressed to allow a 4- minute reaction period. The time keeps often 4minute and a content of citric-acid reagent powder pillow was also added to each sample cell (which served as prepared sample). 2 minute of reaction period was allowed, a blue colour developed and 0.00mg/l Si_{02} displayed on the screen. The light shield closed, the zero soft key was pressed and placed into the cell holder immediately blank was removed. The result in mg/l Si_{02} was display and recorded.

3.1.6 TOTAL DISSOLVED SOLID

Summary of method

The conductivity probe is not ion-selective but measure the sum total of concentrations of the inorganic components of the solution. The total dissolved solid measure expressed the concentration in milligram/litre or grams/litre of the various ions.

Experiment Procedure:

The power was swilled on and the NDS key was entered. The appropriate range was selected and the probe was insert into the sample solution with the vent holes of the probe beyond the sample and the prove was agitated vertically to discharge air bubbles. The reading was allowed to stabilized and recorded.

3.1.7. TEMPERATURE

Summary of method

Conductivity of a solution is affected by the temperature of the solution. The temperature of the solution is measure by a thermatic network in the conductivity probe which provides automatic temperature compensation.

Procedure:

The power key and the OĊ key were pressed and the probe was inserted into the sample above the vent holes of the probe and agitated vertically. The reading displayed on the screen fluctuates and was allowed to stabilize and was recorded.

3.1.8 DISSOLVED OXYGEN (DO) TEST

Winkler titration method was used.

Little amount of distilled water were measure using a measuring cylinder then transfer into a clean empty stock solution bottle. 4g of $MnCl_2$ was dissolved in 10ml of distilled water measured, 3.3g of solution Hydroxide µa OH, 2.0g of potassium iodide was dissolved in the sample (distilled water sample).

2ml $Mncl_2$ (ag), 2ml alkaline iodide and 2ml of concentrated HCl solution (prepared solution) were added to water sample and the mixture was thoroughly shaken.

The amount of iodine formed is directly proportion to the dissolved oxygen.

50ml of the solution was measure and titrated with 0.0125m of sodium throsulfate solution with starch as an indicator. The end point was determined as the blue-black colour totally disappears.

3.1.9 BIOCHEMICAL OXYGEN DEMAND (BOD) TEST

This experiment goes simultaneous with the Dissolved oxygen.

Part of the collected water sample was kept in the dark for 5days at the temperature at which the sample was collected and the other part of the sample was used to determined Dissolved oxygen using winkle titration method.

The mass of the oxygen at the end of 5days from oxygen on day 1, which is the Biochemical oxygen demand (BOD)(mg/l) of the sample

Calculation:

$$\text{BOD, mg/l} = \frac{(D_1 - D_5)\ (\text{Average of bottle vol.})}{\text{Sample volume}}$$

Where Do = initial Do in the sample

D_5 =Do after 5days

3.2.0 COLOUR

Method Used: platinum colbat standard method.

Summary of method

Colour may be expressed as "append" or "true" colour.

The append colour include that from dissolved materials plus that from suspended matter. Filtering out suspended materials the true colour is determined.

Experiment Procedure:

The soft key under the program was entered and DIALnm To 455 was displayed on the screen, while the wavelength was selected automatically. A sample was filled with 25ml of sample and another sample cell which contained a deionized water (the blank) was placed into the cell holder, 0 unite Ptco colour water displayed on the screen. The prepared sample was place also with light shield closed. The result in Ptco units was displayed and recorded.

3.2.1 IRON

Method Used: Phenanthcoline method

Summary of method

The 1, 10 Phenantheolin indicate in the ferrous iron reagent react with ferrous iron in the sample to form an orange colour in proportional to the iron concentration.

Experiment Procedure

The soft key under the HACH PROGRAM of the spectrophotometer was pressed and the stored program number for ferrous iron (Fe^{2+}) numeric keys was entered. HACH PROGRAM: 2150 Iron, Ferrous displayed on the screen and wavelength ( ) 150μm, was automatically selected. A clean sample filled with 25ml of sample and content of one ferron iron reagent powder pillow was added to the sample (the prepared sample) and swilled to mix. The time was adjusted for a 3minute reaction period. A second cell was also filled with 25ml of sample (the blank) which was placed into the cell holder when the time keeps and the soft key under zero was pressed and 0.00mg/l Fe2+ was displayed on the screen. The prepared sample cell was placed into the sample cell holder with the light shield closed. The result was displayed on the screen and recorded.

3.2.2 CONDUCTIVITY

Summary of method

Electrolytic conductivity is the ability of a solution to pass an electric current and is the reciprocal of the solution resistivity. The determination of conductivity is actually performed by measuring the resistant occurring in an area of test solution defined by the design of the probe. A voltage is applied between the two electrodes immersed in the test solution, and the voltage drop caused by the resistance of the solution is used to calculate its conductivity.

Procedure: The power was switched on the conductivity key entered and appropriate range was selected. The probe of the conductivity Tides meter was immersed into the sample in such away that the vent holes of the probe touched the sample and the probe was agitated vertically in order to discharge bubbles. The reading displayed on the screen and was allowed to stabilize and was recorded.

3.2.3 COPPER

Method Used: Bicinchoninate Method

Summary of Method

Copper in the sample reacts with a salt of bacinchoninic acid contained in culver 1 copper reagent to form a purple colour complex in proportion to the copper concentration.

Experimental Procedure

The soft key under HACH PROGRAM of the spectrophotometer was pressed and the stored program number for bicinchoninate copper (1700) numeric keys was entered. HACH PROGRAM: 1700 copper, Bicin was displayed on the screen and the wavelength was automatically selected (560μm). A clean sample cell filled with 10ml of the sample was added 1 powder pillow of culver 1copper reagent and swilled to mix a 2 minute of reaction time was allowed. After 2 minute the time beeped and another sample cell filled with 10ml of sample (the blank) was placed in the cell holder and the soft key under zero was pressed. 0.000mg/l cu displayed on the screen. Within 30 minute the time beeps and prepared sample was placed in the cell holder with light shield closed. The result in mg/l cu displayed on the screen and recorded.

3.2.4 MANGANESE

Method Used: Period ate Oxidation Method

Summary of Method

Manganese in the sample oxidized to the purple permanganate state by sodium period ate, after buffering the sample with citrate. The purple colour is directly proportion to the manganese concentration.

Experiment Procedure:

The soft key under the HACH PROGRAM of the spectrophotometer was pressed and the stored program number for high range manganese (Mn) numerical key was entered. HACH PROGRAM: 2250 Manganese, HR displayed on the screen and the wavelength ( ) was automatically (525nm) selected. A clean sample cell was filled with 10ml of the sample and one buffer powder pillow, citrate type for manganese was added and mixed. Another powder pillow of sodium period ate was added to the sample cell (the prepared sample) and well swilled to mix. A 2 minute of reaction period was allowed and the time beeped after this time, while another sample cell filled with 10ml of the sample (the blank) was placed into the cell holder and the soft key pressed 0.0mg/l Mn displayed on the screen and the sample cell was removed. The time beeps within eight minute and the prepared sample cell was also placed into the cell holder. The result in mg/l Mn displayed and recorded.

3.2.5 NITRATE

Method Used: Cadmium Reduction Method

Summary of Method

Cadmium metal reduces nitrate in the sample to nitrite. The nitrite ion reacts in acidic medium with sulfanilic acid to form an intermediate diazonium salt. The salt couples with chromo tropic acid to firm pink-colour product.

Experiment Procedure:

The soft key under the HACH PROGRAM of the spectrophotometer was pressed and the stored program number for high range nitrate numeric keys was entered. HACH PROGRAM: 2515N Nitrate HR displayed on the screen and the wavelength ( ) automatically (507nm) selected.

A graduated cylinder was filled with 15ml of sample and a content of one Nitra ver 6 reagent powders pillow was to the cylinder. The cylinder was shaken vigorously for 3 minute and the time beeps after another two minute of reaction time and the sample was poured into a 10ml sample cell and a content of one nitri ver 3 nitrite reagent powder pillows was added into the sample cell (the prepared sample). A 15minute of reaction period was allowed and a new sample cell filled with original sample (the blank) was placed into the cell holder with the light shield closed. The soft key was pressed and 0.00mg/l No3 displayed. The prepared sample was also placed and the result displayed and recorded.

3.2.6 pH

A disc was inserted into the lovibond from the side and the sample collected into a smaller cell sample (with one filled with deionized water and the other with the water sample). This two cell sample were placed into the lovibond from the top and two samples were compared by scrolling the phenotheline test disc containing a series of colour glasses filled to cover the range of the test concerned. The visual instrument matched the sample with the colour glasses filter in lovibond test disc by rotating the disc until both sample were seen the same. The PH at this point was noted on the disc and recorded.

TABLE 3.2.1 EXPERIMENTAL RESULT OF THE SOURCE WATER (RAIN WATER) OF CHEMICAL A ND PHYSICAL PARAMETER

PARAMETERS	RESULTS
Total dissolved solid	300mg/l
Colour	550Ptco
Turbidity	147Ntu
PH	7.0
Temperature	30°C
Suspended particle	60.8mg/l
Taste	Raw
Conductivity	90Ns/cm
Iron	2.01mg/l
Nitrate	51.2mg/l
Sulphate	32mg/l
Lead	--
Fluoride	--
Manganese	4.3mg/l
Copper	2.5mg/l
Oxygen.Dissolved	12.9mg/l

TABLE 3.2.3 EXPRIMENTAL RESULTS ON PHYSICAL PARAMETER OF OLD TREATMENT PLANT (Bi-WATER).

WATER SAMPLE BEFORE FILTRATION FROM OLD WATER PLANT		WATER SAMPLE AFTER FILTRATION FROM OLD WATER PLANT	
PARAMETERS	RESULTS	PARAMETERS	RESULTS
Total dissolved solid	47.4mg/l	Total dissolved solid	47.8mg/l
Colour	31.0Ptco	Colour	33.0Ptco
Turbidity	6.0Ntu	Turbidity	7.0NTu
PH	8.0	PH	7.6
Temperature	31.3°C	Temperature	31.3°C
Suspended particles	1.0mg/l	Suspended particles	1.0mg/l
Taste	Nice	Taste	Nice
Conductivity	94.8µs/cm	Conductivity	95.7µs/cm

TABLE 3.2.3 EXPERIMENTAL RESULTS ON CHEMICAL PARAMETERS OF OLD PLANT (Bi-WATER).

WATER SAMPLE BEFORE FILTRATION FROM OLD WATER PLANT		WATER SAMPLE AFTER FILTRATION FROM OLD WATER PLANT	
PARAMETERS	RESULTS	PARAMETERS	RESULTS
Iron	0.12mg/l	Iron	0.57mg/l
Nitrate	40.7mg/l	Nitrate	20.5mg/l
Sulphate	41.0mg/l	Sulphate	55.0mg/l
Lead	------	Lead	------
Fluoride	------	Fluoride	------
Silicon	1.012mg/l	Silicon	0.610mg/l
Manganese	43.4mg/l	Manganese	4.3mg/l
Copper	2mg/l	Copper	1.2mg/l
Oxygen dissolved	8.9mg/l	Oxygen dissolved	8.9mg/l

TABLE 3.2.4 EXPERIMENTAL RESULTS ON PHYSICAL PARAMETERS OF NEW TREATMENT PLANT (IMPRESIT).

WATER SAMPLE BEFORE FILTRATION FROM NEW PLANT		WATER SAMPLE AFTER FILTRATION FROM NEW PLANT	
PARAMETERS	RESULTS	PARAMETERS	RESULTS
Total dissolved solid	50.6mg/l	Total dissolved solid	49.5mg/l
Colour	18.0Ptco	Colour	8.0Ptco
Turbidity	4.0NTu	Turbidity	2.0NTu
PH	7.4	PH	7.0
Temperature	31.1°C	Temperature	31.2°C
Suspended particles	0.0	Suspended particles	0.0
Taste	Nice	Taste	Nice
Conductivity	101.3μs/cm	Conductivity	99.0μs/cm

TABLE 3.2.5 EXPERIMENTAL RESULTS ON CHEMICAL PARAMETERS OF NEW TREATMENT PLANT (IMPRESIT).

WATER SAMPLE BEFORE FILTRATION FROM NEW PLANT		WATER SAMPLE AFTER FILTRATION FROM NEW PLANT	
PARAMETERS	RESULTS	PARAMETERS	RESULTS
Iron	0.09mg/l	Iron	0.08mg/l
Nitrate	35.8mg/l	Nitrate	12.2mg/l
Sulphate	42.0mg/l	Sulphate	50mg/l
Lead	------	Lead	-------
Fluoride	------	Fluoride	-------
Silicon oxide	0.564mg/l	Silicon oxide	0.318mg/l
Manganese	4.2mg/l	Manganese	4.2mg/l
Copper	1.18mg/l	Copper	0.78mg/l
Oxygen Dissolved	8.6mg/g	Oxygen Dissolved	5.6mg/l

TABLE 3.2.6 REQUIRED REAGENT AND STANDARDS

PARAMETERS	DESCRIPTION	QUANTITY REQUIRED PER TEST
Iron	Ferrous Iron reagent powder pillow	1 pillow
Turbidity	Water, deionized	1 pillow
Silica	Amino acid reagent powder pillow	1 pillow
	Citric Acid powder pillows	2 pillow
	Molybdate 3 reagent solution	10ml
Sulphate	Sulphate, sulfa ver 4 reagent powder pillow	1 pillow
	water, deionized	25ml
	water, deionized	10ml
	phenontheline	2drops
Dissolved oxygen	water, deionized, sodium Hydroxide, potassium iodide, Alkaline iodide, Hydrochloric acid solution	1 pillow
Copper	Cuver 1 Copper reagent powder Pillow	
Manganese	Buffer powder pillow, citrate type for manganese	1 pillow
	Sodium period ate powder pillows, for manganese	1 pillow
Nitrate	Nitra ver 6 reagent powder pillows	1 pillow
	Nitri ver 3 reagent powder pillows	1 pillow

3.3 DISCUSSION OF RESULT

There is no such thing as naturally pure water in nature, all water contained some impurities. As water flows in stream, river, sits in dams and lakes, and filters through layers of soil and rocks in the ground. It dissolved or absorbs the substance that it touched. Some of the substances are harmless. In fact, some minerals in water give its appealing taste. However, at certain levels minerals, just like man-made chemicals are considered contaminants that can make water unpalatable or can unsafe.

The result from table 3.2.2, 3.2.3, 3.3.3, 3.3.4 and 3.2.5 revealed that some of these chemical parameters are above the provisional guideline values, despite the daily analysis and applications of desired treatment methods. The addition of necessary chemicals and disinfectants to the water, which allows the dirt and other contaminants form clumps that settle to the bottom of the tank, while the water flows through a filter for removal of the smallest contaminants in the water. With these necessary procedure the result obtained still deviate from standard values, like the copper constituent which 2times the provisional guideline value which could result to gastrointestinal effect and also result to chronic effect like cancer, liver and kidney problems. The high result level dissolved oxygen in table 3.3.3 which enhanced lives of microbes. Therefore from the experiment results, it is very true to say that the technology of the old treatment plant (Bi-water) is not only out dated, but also that it has outlived its usefulness. Other factors experienced was the changed in the conceptual design of the new treatment plant (Impresit) due to lack of proper maintenance which leads to weakness in the plants and affects its effectiveness. since most of this chemical has formed large compound due to the coagulant added to the water therefore, escape of these floucs and resides depend on the porosity of the bed sand of the filter and the diameter of sand. The larger the diameter of the sand the more impurity passes through and the smaller the diameter the more it is impermeable to the residues and floucs. Enhance could affect the result and effectiveness of the unit.

CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

The result from the water analyses of Minna filtration plant that was carried out revealed clearly that the old treatment plant (Bi-water) is not effective since there were no significant difference between the result obtained from the treated water sample before passing through the filtration plant and the result obtained after the treated water was passed through the filtration plant. But the new treatment plant (Impresit) shows an encouraging difference between the results obtained in the water samples before passing through the filtration plant and after the treated water was filtered through the filtration plant, which signifies that the new treatment plant (Impresit) is effective.

Some physical parameters such as turbidity, which contributes to the colour, the taste and the conductivity of the water was showed from the experimental results to have been reduced to a minimal value appreciable and within the permissible limit in accordance to world health organization water standard. While the results obtained for the copper, manganese and nitrate were above the permissible limit of world health organization standard which could result from improper treatment procedures or equipments.

Therefore it is true to say that the old water treatment plant (Bi-water) is not effective and the new treatment plant is better and preferable but needs adequate and proper maintenance.

4.2 RECOMMENDATION

Basically an alternative should be provided to supplement the ineffectiveness in the old treatment water plant in other to meet the demands of the consumers and to reduce the danger on water supplied to the Minna environ. The new treatment plant needs frequent maintenance to maintain the conceptual design procedures and the old needs a replacement. This could be achieved by designing of a new plant. More reagents should be provided to encourage the determination of other chemical parameters which reduce the populace to exposure of danger on potable water.

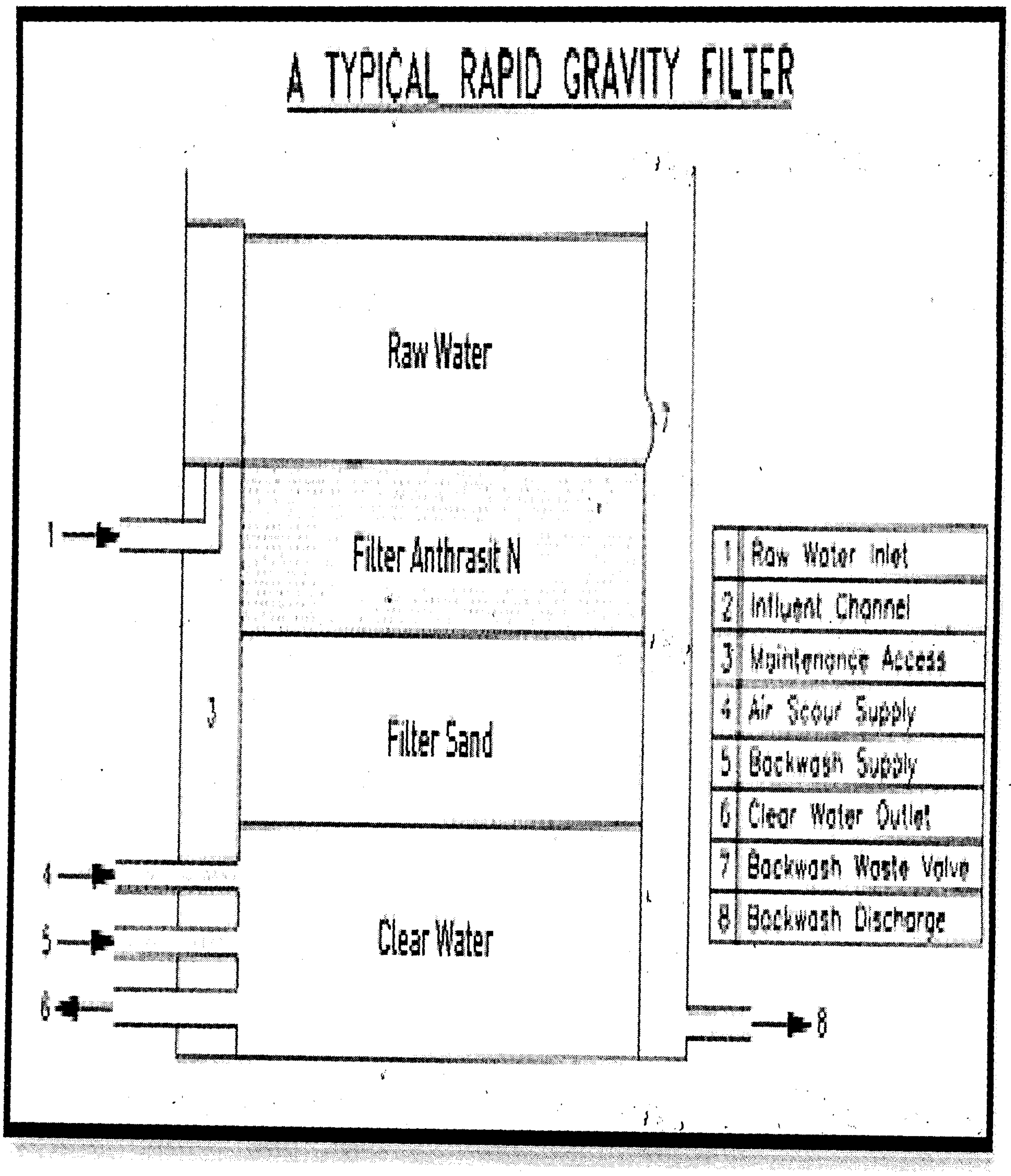
Once a potentially hazardous situation has been recognized, however a risk to health, the availability of suitable remedial measures must be considered to reduce the exposure of the populace from possible hazardous effect. For optimal quality the bed sand of the filtration unit should chanced. For rapid gravity filter unit

Type of sand, should be high silica content sand

Size ranging from 0.71mm to 0.21mm .Specific Gravity (approx.) 2.6 Silica Content > 96%

Appearance: Light Brown

Note: It is recommended to support filter sand on a good quality natural support gravel to prevent any possible sand migration through the filter bed.


A TYPICAL RAPID GRAVITY FILTER
Raw Water
Filter Anthrasit N
Filter Sand
Clear Water
1
2
3
4
5
6
7
8
1 Raw Water Inlet
2 Influent Channel
3 Maintenance Access
4 Air Scour Supply
5 Backwash Supply
6 Clear Water Outlet
7 Backwash Waste Valve
8 Backwash Discharge

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