DEDICATION

Affectionately dedicated to Almighty God, my guardian Mr Gabriel Agodo, my father, my mother and other members of my family who did credibly well towards my academic pursuit especially to this project work.

Also dedicated to my fiance Serah N Samuel and my friend Mr. Kehinde James Jomoh and Mr. Sunday Ndaba

CERTIFICATION

This is certify that this design project title design of circular primary sedimentation tank for treatment of waste water" was carried out by him, under supervision and submitted to the department of Chemical Engineering ,Schools of Engineering Technology, Minna.

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Supervisor

Mr. Abdulkareem S.A. Date.

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Head of Department

Dr. J.O. Odigure. Date.

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EXTERNAL EXAMINER Date.

ABSTRACT

A design of the waste water treatments Plants deals mainly with circular Primary sedimentation tank. The tank is equipped with scrapper.

The area of the circular Primary sedimentation tank was **1257.7m^2**, the height was **3.6m** and the diameter is **12.65m**, the sludge volume is **2.492m^3\100m^3** and the volume of the tank **452.808m^3**

The power requirement was **10kw\day** and the total cost of the tank **₦238,568.58.**

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CHAPTER ONE

1.0 INTRODUCTION

The value of water to the existence of humanity cannot be overemphasized and its benefits without price. The same can be said for the negative effects of wastewater to the environment and to man.

The need for systems of water sanitation became evident as urban areas developed without adequate provision for water supply and waste removal. Accumulations of waste matter resulted in the contamination of water supplies resulting in high mortality rate from water borne diseases such as typhoid, cholera, dysentery and so on.

Every community produces both liquid and solid wastes. Effluent disposal focuses on the transport of contaminants in the environment and the transformation processes that occur. To ensure that effluent disposal is accomplished in conformance with environmental requirements, rigorous analysis must be performed. Mathematical modeling techniques are used, involving the application of material balances.

Engineering design is the use of scientific principles, technical information and imagination in the definition of a mechanical structure, machine or system to perform prespecified functions with maximum economy and efficiency [1]. Thus for the design of a wastewater treatment plant, the subjects of source control, collection and transmission, must be studied by the engineer. At one end of the quality spectrum of water lie objectives and standards for safe and palatable drinking waters; at the other end are quality requirements of spent waters or wastewater effluents to be introduced into receiving bodies of water. The plant design focused in this work is for the later quality requirement.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 BACKGROUND STUDY

In the past, the disposal of wastewater in most municipalities and communities was carried out by the easiest method possible without much regard to unpleasant conditions produced at the place of disposal (2). Irrigation was probably the first method of wastewater disposal, although dilution was the earliest method adopted by most municipalities. With increased industrial and urban development, effluent disposal and its effects on the environment now require special consideration.

Surface water discharge remains the most common method of wastewater disposal. To protect the aquatic environment receiving water standards for streams, rivers, and estuarial and costal waters have been developed. In a number of places, treatment plants have been designed and located so that a portion of the treated effluent can be disposed of by land application in conjunction with a variety of reuse applications such as irrigation, use as industrial cooling water and ground water recharge.

2.2 WASTEWATER CHARACTERISTICS

The characteristics of wastewater vary widely and are dependent on its source – industrial or domestic. Obviously the specific will affect the treatment techniques for use in meeting requirements. The general characteristics considered during planning can be divided into physical, chemical and biological characteristics.

2.2.1PHYSICAL CHARACTERISTICS

2.2.1.1 TOTAL SOLIDS CONTENT

This is the most important physical characteristic of wastewater. It is composed of floating matter, colloidal matter, and matter in solution. The total solid content in wastewater is defined as the all the matter that remains as residue upon evaporation at 103 – 105oC. It can be classified as either suspended solids or filterable solids. The suspended solids are an approximate measure of the quantity of sludge that will be removed by sedimentation.

2.2.1.2 ODORS

Odors in wastewater are usually caused by gases produced by decomposition of organic matter. The most characteristic odor of stale or septic wastewater is that of hydrogen sulphide, which is produced by anaerobic microorganisms that reduce sulphate to sulphide.

2.2.1.3 TEMPERATURE

The temperature of wastewater is generally higher than that of water supply. This is because of the addition of warm water from households and industrial activities. Temperature is a very important parameter because of its effect on aquatic life, chemical reaction and reaction rate.

2.2.1.4 COLOUR

The colour of fresh wastewater is usually gray, however, as organic compounds are broken down by bacteria, the dissolved oxygen in wastewater reduces to zero and the colour changes to black.

2.2.2 CHEMICAL CHARACTERISTICS

2.2.2.1 ORGANIC MATTER

In a typical wastewater composition, about 75% of the suspended solids and 40% of the filterable solids are organic in nature. These solids are derived from both animal and plant kingdoms and the activities of man as related to synthesis of organic compounds. The principal groups of these substances are – Protein (40 – 60%), Carbohydrates (25 – 50%), Fats and oil (15 – 10%). Urea is another important organic compound contributing to wastewater. The presence of these substances has in recent years complicated wastewater treatment. This is because many of them cannot be or are very slowly decomposed biologically.

2.2.2.2 INORGANIC MATTER

Several inorganic components of wastewater are important in establishing and controlling water quality. The concentration of inorganic constituents is increased by the natural evaporation process, which removes some of the surface water leaving the inorganic substances in water.

2.2.2.3 GASES

Gases commonly found in wastewater include Nitrogen, Oxygen, Carbon dioxide, Hydrogen sulphide, Ammonia and Methane. The first three are common gases of the atmosphere and will be found in all water exposed to air. The others are derived form the decomposition of organic matter found in wastewater.

2.2.3 BIOLOGICAL CHARACTERISTICS

2.2.3.1 MICROORGANISMS

The principal group of organisms found in wastewater are protiska plants and animals. The bacterial algae and protozoa play an extensive and fundamental role in the decomposition and stabilization of organic matter, both in nature and in treatment of water supply, because they often cause taste and odor problems.

2.3 SOURCES OF WASTEWATER

There are two main sources of wastewater

- Domestic wastewater
- Industrial wastewater

The principal sources of wastewater in a community are the residential and commercial districts. Other important sources include institutional and recreational facilities. Industrial wastewater varies with the type and size of industry, they occur as a result of spills leaks and product washing.

Domestic wastewaters are generally handled by the normal sanitary sewage systems to prevent the spread of pathogenic microorganisms, which cause diseases. On the other hand industrial wastewater have no potential for pathogenic microorganisms but pose a treat to the environment either by direct or indirect chemical reactions and they require more complex treatment methods.

For this design the source of wastewater to be treated is considered as domestic.

2.4 CLASSIFICATION OF WASTEWATER TREATMENT METHODS

The contaminants in wastewater are removed by physical, chemical and biological means. The individual methods usually classified as physical unit operations, chemical unit processes and biological unit processes. Although these operations and processes occur in a variety of combinations in treatment systems their scientific basis is studied separately because the principles involved do not change.

2.4.1 PHYSICAL UNIT OPERATIONS

Treatment methods in which the application of physical forces predominates are known as physical unit operations. Due to the fact that these methods evolved directly from man's first observations of nature, they were the first to be used for wastewater treatment. Screening, mixing flocculation, sedimentation, flotation and gas transfer are typical unit operations.

2.4.2 CHEMICAL UNIT PROCESSES

These are treatment methods in which the removal or conversion of contaminants is brought about by the addition of chemicals or by other chemical reactions. Precipitation adsorption and disinfections are the most common examples used in water waste treatment.

In chemical precipitation, treatment is accomplished by producing a chemical precipitate that will settle.

In most cases, the settled precipitate will contain both the constituents that may have reacted with the added chemicals and the constituents that were swept out of the wastewater as the precipitate settled. Adsorption on the other hand involves the removal of specific compounds from the wastewater on solid surfaces using the force of attraction between the bodies.

2.4.3 BIOLOGICAL UNIT PROCESSES

Biological unit processes are treatment methods in which the removal of contaminants is brought about by biological activity. It is used primarily to remove biodegradable organic substances (colloidal or dissolved) in wastewater. Basically these can escape to the atmosphere and into biological cell tissue that can be removed by settling.

Biological treatment is also used to remove nutrients (nitrogen and phosphorus) in wastewater. With proper environmental control, wastewater can be treated biologically in most cases, thus provision of an appropriate environment is required for this process to operate effectively.

2.5 CHOICE OF METHOD

Unit operations and processes are grouped together to provide various levels of treatment. The term preliminary and primary refer to physical unit operations; secondary refers to chemical or biological unit processes; and advanced/ tertiary a combination of all three.

The level of contaminant removal for this design is for discharge into water bodies. Thus the required unit operations and processes used are the preliminary, primary and secondary treatment methods.

2.6 PRELIMINARY TREATMENT

This section is concerned with the removal of wastewater constituents that may cause maintenance or operational problems. In the design of this wastewater treatment plant this section has the following units:

2.6.1 SCREENING

This is the first unit operation encounted in wastewater treatment plants. It is a device with openings generally of uniform size that is used to retain solids found in wastewater some of which are debris, rags, polyethylene and other large material that may cause wear or clogging of equipment. The solids are flushed out by sprays from the exposed screen surface into a collecting trough in each revolution.

2.6.2 GRIT CHAMBER

These are designed to remove grit consisting of sand, gravel, cinders, egg shells, seeds, bone chips, food wastes, or other heavy solid materials that have subsiding velocities or specific gravities substantially higher than those of the organic putrescible solids in waste water.

Grit chambers are provided to protect moving mechanical equipment from abrasion, and accompanying abnormal wear; reduce formation of heavy deposits in pipelines, channels and conduits; and reduce the frequency of cleaning caused by excessive accumulation of grit. Thus its location ahead of the other units facilitates operation. Wastewater is best treated with aerated grit chambers, which provides the rapid sepration of these particles. Diffused air is normally used to create the mixing pattern with heavy inert particles removed by centrifugal action and friction against the tank walls.

2.7 PRIMARY TREATMENT

Here a portion of suspended solids and organic matter is removed. The principal function of primary treatment is as a precursor to secondary treatment.

2.7.1 PRIMARY SEDIMENTATION TANK

The objective of treatment of sedimentation is to remove readily settleable solids and floating material, and thus reduce the suspended solids content. Primary sedimentation may provide the principal degree of wastewater treatment or may be used as a preliminary step to further processing.

The use of primary sedimentation ahead of biological treatment reduces the load on the biological treatment units allowing for shorter detention periods. Efficiently designed primary sedimentation tanks should remove 50 to 70% of the suspended solids and 25 to 40% of the BOD.

2.8 SECONDARY TREATMENT

This is directed principally to the removal of biodegradable organics and suspended solids. In this the biological method is adopted.

2.8.1 AREATION TANKS

It is operationally a biological waste treatment method with activated sludge treatment typically accomplished by introducing the wastewater into a reactor where an aerobic bacteria culture is maintained (aeration tanks).

In these tanks the aerobic environment is achieved by exposing the wastewater to air either by pumping using submerged diffusers, or to agitate the wastewater mechanically so as to promote solution of air from the atmosphere. This converts the wastewater into flocculant settlable biological and inorganic solids that can be removed in sedimentation tanks. About 90 to 95% BOD's are removed successfully.

DESIGN OF CIRCULAR PRIMARY SEDIMENTATION TANK FOR THE TREATMENT OF ONE HUNDRED MILLION LITRES PER DAY OF WASTE WATER

BY

YISA SUNDAY . G.

MATRIC NO:-95/4655

A DESIGN PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF A B.ENG..DEGREE IN THE DEPARTMENT OF CHEMICAL ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

DECEMBER 2000

2.8.2 SECONDARY SEDIMENTATION

The function of the activated sludge-settling tank (secondary sedimentation tank) is to separate the activated-sludge solids from the mixed liquor. In contrast to the primary sedimentation tank, the secondary sedimentation tank must cater for the presence of the large volume of flocculant solids in the mixed liquor. Solids separation is the final step in the production of a well-clarified, stable effluent low in BOD and suspended solids.

2.8.3 THICKENER

The solids content of primary, secondary, or primary and secondary vary considerably, depending on the characteristics of the sludge, the sludge removal, pumping facilities and the method of operation. A thickener is a device used to increase the solid content of sludge by removing a portion of the liquid fraction. Thickening is usually accomplished by physical means, including gravity settling, flotation, centrifugation and gravity belts. The liquid obtained from this unit is usually recycled for further treatment.

The biological method of treatment was chosen for this design cause it is relatively cheap and does not involve the use of chemicals, thus erasing the need to cater for their effect. Since this method is more of a natural treatment, it is environmentally friendly.

CHAPTER THREE

3.0 FLOW DIAGRAM OF PLANT

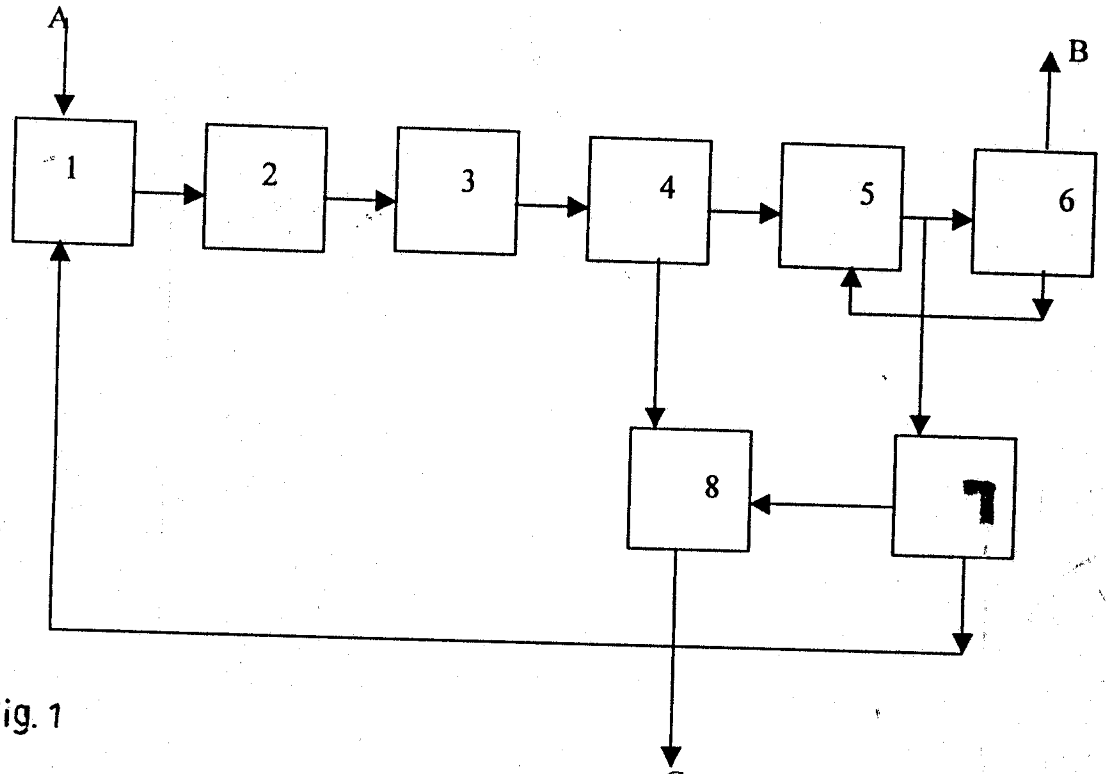


fig. 1

KEY:

1 – Pump Station

2 – Screening Unit

3 – Aerated Grit Chamber

4 – Primary Settling Tank

5 – Aeration Tank

6 – Secondary Sedimentation Tank

7 – Thickener

8 – Disposal Tank

A – Wastewater influent

B – Treated Effluent to Waterway

C – Thickened Sludge

3.1 MATERIAL BALANCE

DATA:

Wastewater Flowrate

(i) Average dry weather flow (ADWF) = 100,000,000 l/day

(ii) Peak dry weather flow = peak factor x flowrate = $2.5 \times 100 \times 10^6 = 2.5 \times 10^8$

Influent Characteristics:

(i) BOD = 220mg/l

(ii) Suspended Solids (S.S) = 220mg/l

(iii)Suspended Solids after grit removal (10% of suspended solid removed by grit)

= 198mg/l

Grit Characteristics:

Quantity of grit = 0.005% of ADWF = 0.005% of 100×10^6

= 5000 l/day

$= \frac{5m^3}{100000cm^3} \quad = \frac{0.05m^3}{1000m^3}$

Unit mass = specific gravity x density of water = 2.65 x 1000 = $2650 Kg/m^3$

Solid Characteristics:

(i) Concentration of primary solid = 6%

(ii) Concentration of thickened wastewater activated sludge = 4%

(iii) Total solid in Digested sludge = 5%

(iv) Specific gravity of solids from primary sedimentation tank and thickener=1.03

Effluent Characteristics:

(i) BOD = 20mg/l

(ii) Suspended Solids = 25mg/l

The given constituents are converted to daily mass values

NOTE – 100,000,000 l/day = $100,000 m^3/day$

BOD in influent (Kg/day)

$$\frac{100000 \times 220}{1000} = \underline{22000 Kg/day}$$

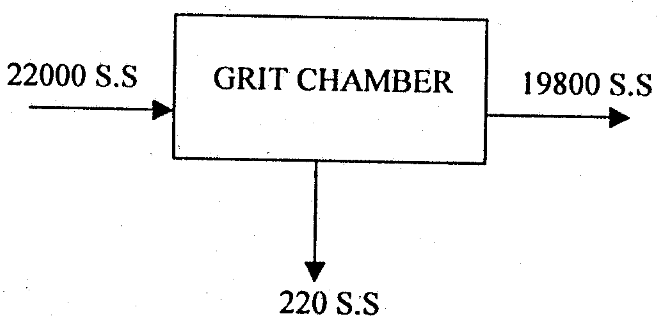
Suspended solids in influent (Kg/day)

$$= \frac{100000000 \times 220}{1000 \times 1000} = 22000 Kg/day$$

Suspended solids after grit removal (Kg/day)

$$= \frac{100000000 \times 198}{1000 \times 1000} = 19800 Kg/day$$

3.1.1 MATERIAL BALANCE ON GRIT CHAMBER



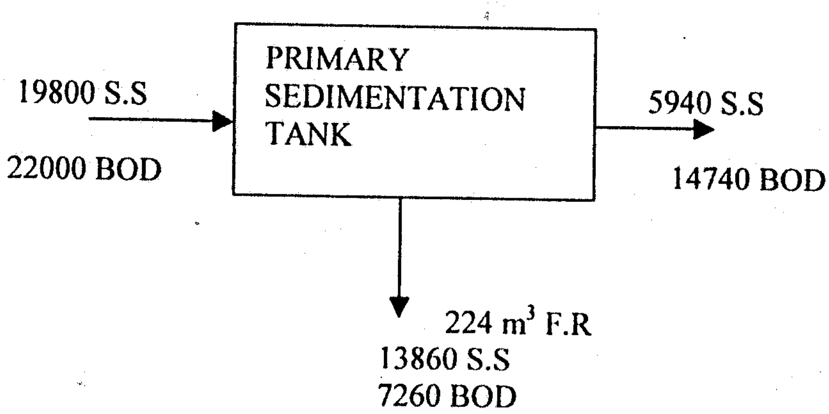
10 % of suspended solid (S.S) is removed

$$= \frac{10}{100} \times 220 = 22 \text{ mg/l}$$

S.S after grit removal = 220 – 22 =198 mg/l

$$\frac{100000 \times 198}{1000} = 19800 Kg/day$$

3.1.2 MATERIAL BALANCE ON PRIMARY SEDIMENTATION TANK



Operating Parameters

BOD removed = 33%

S.S removed = 70%

Thus,

BOD removed = 0.33 (22000) = 7260Kg/day

BOD to secondary sedimentation tank = 22000 – 7260 = 14740Kg/day

S.S removed = 0.7 (19800) = 13860Kg/day

S.S to secondary sedimentation tank = 19800 – 13860 = 5940Kg/day

3.1.3 DETERMINATION OF VOLATILE FRACTION OF PRIMARY SLUDGE

Operating Parameters

Volatile fraction of S.S in influent prior to grit removal

$$= \frac{165}{220} \times 100 = 75\%$$

Volatile fraction of grit = 10%

Volatile fraction of incoming S.S discharged to secondary process = 85%

(i) Volatile S.S in influent prior to grit removal (Kg/day)

= 0.75 (22000) = 16500 Kg/day

(ii) Volatile solids removal in grit chamber

= 0.10 (22000 – 19800) = 220 Kg/day

(iii) Volatile S.S in secondary influent

= 0.85 (5940) = 5049 Kg/day

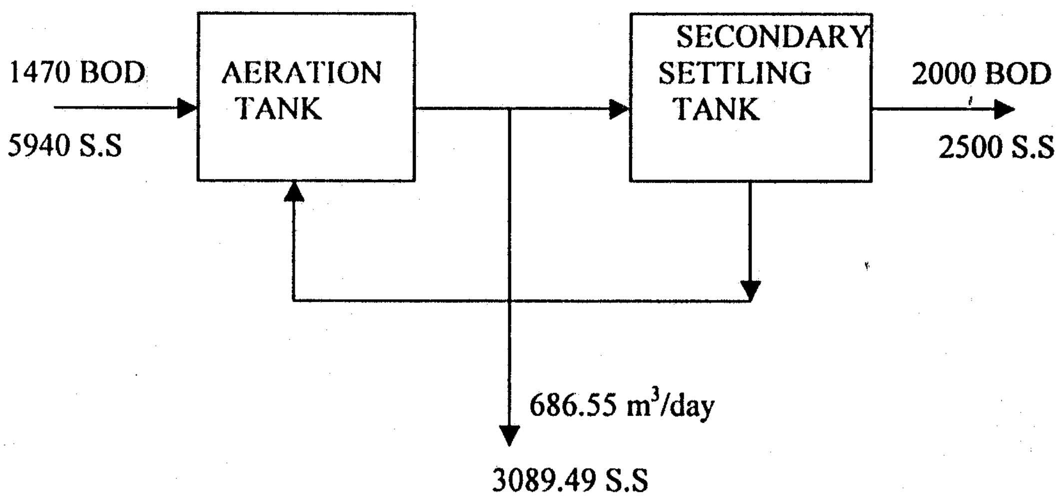
(iv) Volatile S.S in primary sludge

= 16500 – 220 – 5049 = 11231 Kg/day

(v) Volatile fraction in primary sludge

$$= \frac{11231 \times 100}{16500} = 68.07\%$$

3.1.4 MATERIAL BALANCE ON AERATION AND SECONDARY SEDIMENTATION TANKS



Operating Parameters

Mixed liquor Suspended Solid (MLSS) = 4500 mg/l

Retention time θc d = 10 d

F/m Kg BOD applied/ Kg MLSS = 0.4

Volumetric loading Kg BOD applied /m^3 d =1.4

VQh = 4

Qr / Q =0.75

Volatile fraction of mixed liquor S.S = 0.80

Yield observed (Y_{obs}) = 0.3125

(i) Effluent mass quantities

BOD in Kg/day = 100000000 l/day x 20mg/l x 10^{-6}mg/Kg = 2000Kg/day

$$\text{S.S in Kg/day} = \frac{100000000 \times 25}{1000 \times 1000} = 2500 \text{ Kg/day}$$

(ii) Estimate of mass of volatile solids produced in the activated sludge process that must be wasted

$Px (S.S) = Y_{obs} Q (So - S) (10Kg/Kg)^{-1}$

So = 0.67 (220) = 147.4 mg/l

S = 4.30mg/l, Q = 100000 m^3/day, Y_{obs} = 0.3125

Therefore,

$$Px\ (S.S) = 0.3125\ (100000)\ (147 - 4.30)\ (10Kg/Kg)^{-1}$$

$$= 4471.59 Kg/day$$

(iii) Mass of S.S that must be wasted assuming volatile fraction is 0.8 of total solids

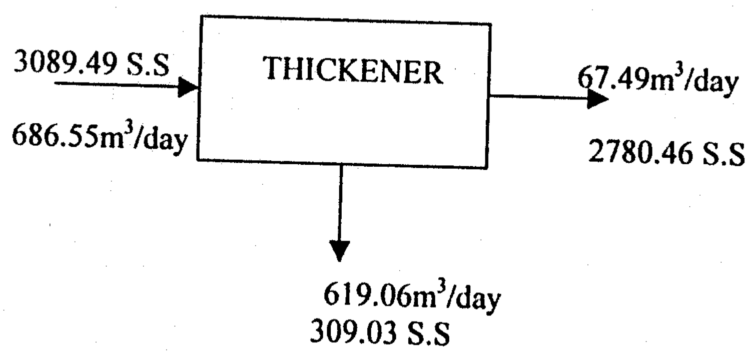
$$S.S\ (Kg/day) = \frac{4471.59}{0.8} = 5589.49 Kg/day$$

(iv) Waste quantities discharged to the thickener

$$S.S\ (Kg/day) = 5589.49 - 2500 = 3089.49 Kg/day$$

$$\text{Flowrate}\ (m^3/day) = \frac{3089.49 \times 1000}{4500} = 686.55 m^3/day$$

3.1.5 MATERIAL BALANCE ON THICKENER



<u>Operating Parameters</u>

Concentration of thickened sludge = 4%

Solid recovery = 90% (assumed value)

Specific gravity of feed thickened sludge = 1.03

Density = $1.03 \times 1000\ Kg/m^3$

(i) Flowrate of thickened sludge

$$= \frac{3089.49 \times 0.9}{1030 \times 0.04} = 67.49 m^3/day$$

(ii) Flowrate recycled to plant headwork

$$= 686.55 - 67.49 = 619.06 m^3/day$$

(iii) S.S to disposal tank

= 3089.49 x 0.9 = 2780.46Kg/day

(iii) S.S recycled to plant headworks

= 3089.49 – 2780.46 = 309.03Kg/day

(iv)BOD recycled

S.S in recycled flow = $\frac{309 \times 1000}{619.06}$ = 499.19Kg/day

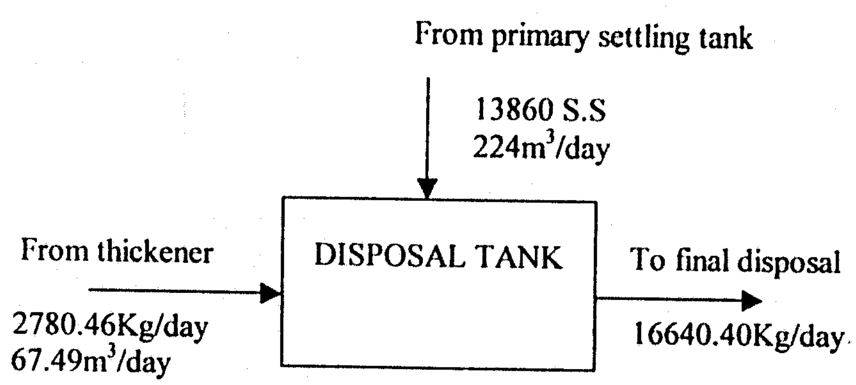
BOD of S.S = 499.19 (1.42) (0.68) (0.65) = 313.31mg/l

Soluble BOD escaping treatment = 4.309mg/l

Total BOD concentration = 313.31 + 4.309 = 317.619mg/l

BOD (Kg/day) = $\frac{317.619 \times 619.06}{1000}$ = 196.63Kg/day

3.1.6 MATERIAL BALANCE ON DISPOSAL TANK



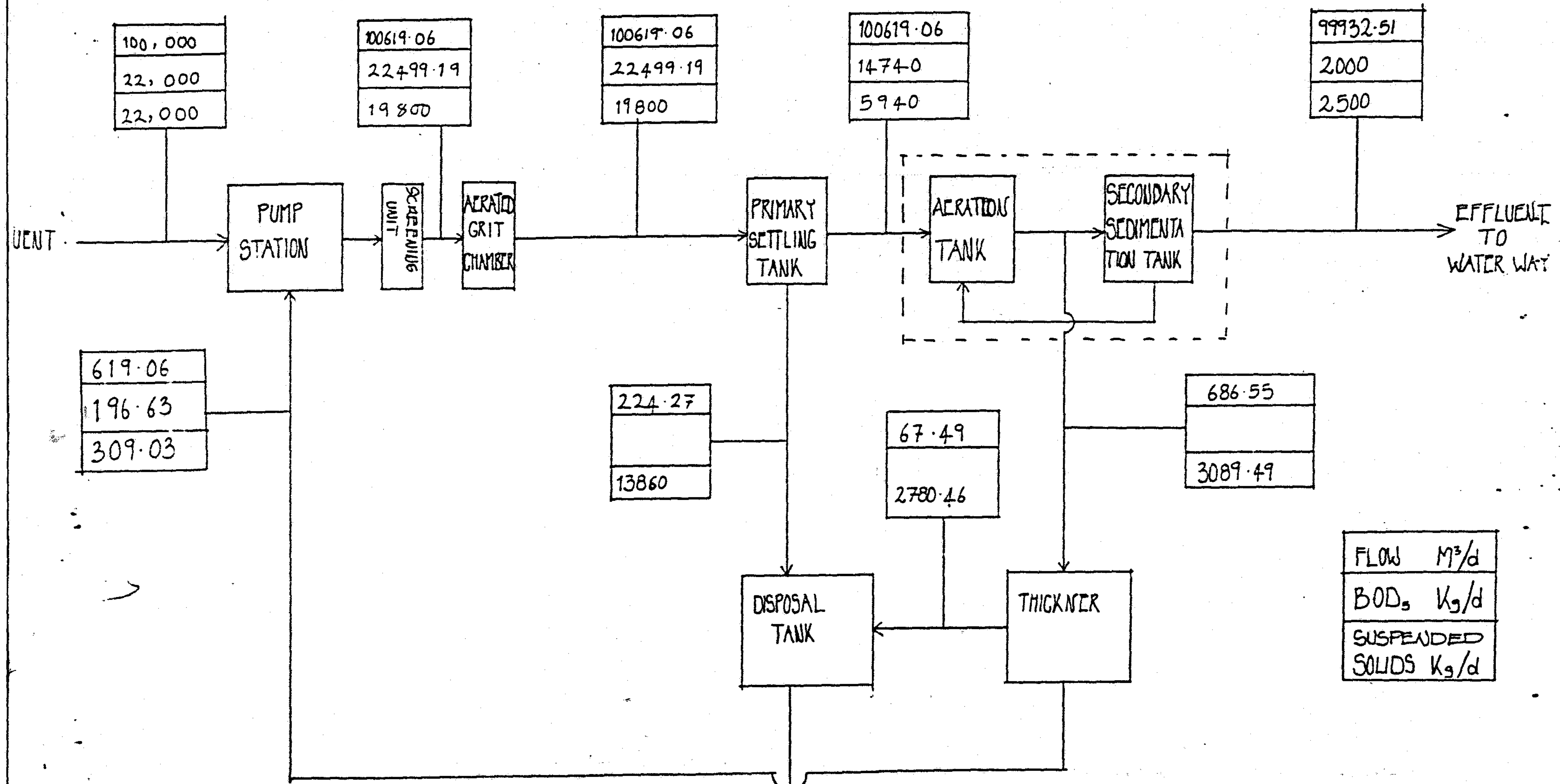


FIG 8·2 FLOW DIAGRAM AND MATERIALS BALANCE ON WASTEWATER TREATMENT PLANT

CHAPTER FOUR

4.0 EQUIPMENT DESIGN

4.1 PRIMARY SETTLING TANK

4.1.1 INTRODUCTION

The primary settling tank function to remove settable solids from the waste stream by gravity. The major design parameter is the overflow rate which is the flow rate Qh divided by the cross sectional flow rate area of the tank A. in order for a particle (and / or agglometric of particles) to settle effectively. this parameter must be less than the characteristic settling velocity of particles. It has been observed that very low values of the overflow rate result in poor flow patterns, flow channeling and flow disturbances from the wind.

Secondary design consideration involve the height and the diameter. The height (H_1) for a given overflow rate, determine the resident time the waste spend in the primary settling tank. Enough time is necessary to form a reasonably thick sludge blanket for proper operations of the removal equipment: on the other hand. a resident time which is too large could result in the sludge becoming too" Old" leading to the microbial anaerobic action. Usually. the height is set at about 4m. diameter of the primary settle tank normally do not exceed 70m because of wind effect causing surface disturbances and because of design difficultir\es in the sludge rating mechanism.

4.1.2 DESIGN

Design data for circular tank

Depth of tank 3.6m

Length of detention time 2hours

Peak flow rate = Average flow rate x Peaking factor

$$A.\hat{o}.E.R. = \frac{BER}{\text{Peaking factor}}$$

P of R = $100m^3/m^2.d$ (Typical value)

Peaking factor = 2.5 (Typical value)

$$A.O.F.R. = \frac{1000m^3/m.d}{25}$$

$= 40m^3/m^3.d$

$$\text{Average over flow rate} = \frac{\text{flow rate}}{\text{Cross sectional area}}$$

$$\text{Cross sectional area} = \frac{\text{Flow rate}}{A.O.E.R.}$$

$$= \frac{100619.06m^3/d \times ½}{40m3/m^2.d}$$

$= 2515.177m^2 \times ½$

$= 1257.74m^2$

Height of tank = $3.6m/m^3$

Volume = $4528.08m^3$

4.1.2.1 To calculate the diameter of tank

$V = \pi r^2 h$

$452.808 = \frac{22}{7} x3.6 \times r2$

$r = \sqrt{40.0209}$

$r = 6.327481133m$

There the diameter of tank = 2 x r

= 12.65496227m

4.1.2.2 ESTIMATIOIN OF SLUDGE

From primary settling tank medium strength waste water

Assumed: Removal efficiency of suspended solid is 70%

Retention time = 2 Hours

Specific gravity of primary sludge = 1.03

Solid concentration = 6% (Typical value)

(i) Total suspend solid : 220mg./ litre

(ii) Mass of dry solids removed per $1000m^3$

$$= \frac{0.7 \times 220 \ g/m^3 \times 1000m^3}{10000g/kg}$$

(iii) Volume of sludge

Data:-

Specific gravity = 1.03

Moisture content = (100-6)%

= 94%

Volume of sludge / $1000m^3$:-

$$\frac{154}{1.03 \times 1000kg/m^3 (0.06)}$$

$= 2.492m^3 / 1000m^3$

CHAPTER FIVE

5.0 ECONOMICAL ANALYSIS ON EQUIPMENT DESIGN

(i.e DESIGN OF CIRCULAR PRIMARY SETTLE TANKS)

5.1 FIXED COST (EQUIPMENT COSTS)

The equipment cost for the primary settling is made up of four major element:- namely. mixing tank. crapper, pump and maintenance.

5.1.1 COST OF MIXING TANK

The cost of the mixing tank was usually calculation from its four basic elements: namely. Excavation, Compaction. base and wall concrete construction.

The converting cost to 1995 by Abititi- Price (Young 19991) the resulting power law relationship is

$Ce_{in} = 48.750D_i^{0.58} \times 1000$

Where D_i is the diameter

- The cost of Excavation $= 48.750 \times (4.6)m^{0.58} \times 100$

  = N 11813.38

- The cost of Compact base $= 48.750 \times (14.655)m^{0.58} \times 100$

  = N 23133.77

- The cost of Concrete base $= 48.750 \times (12.65496)^{0.58} \times 100$

  = N 21246.42

- The cost of concrete walls = 48.750 x (3.6)0.58 x 100

  = N10249.79

The total cost of mixing tank = the sum of Excavation cost. compact base cost. concrete base cost and concrete wall ccost.

= N11813.38 +N 23133.77 +N21246.42 +N10249.79

= N66441.36

5.1.2 The cost of scrapper

$48.25 \times D^{0.58} \times 100$

$= 48.25 \times (10.6)m^{0.58} \times 100$

=N18974.69

5.1.3 The cost of Sludge Pump

The cost a sludge pump with an assumed efficiency of 40% an out put pressure of 40m was provided

= N 50,000.00

5.1.4 Maintainces = 5% it fixed cost of : mixing tanks. the cost of scrapper and the cost sludge pump.

5% of (50,000 +18974.69 +66441.36)

$\frac{5}{100} \times 75616.05$

= N3780.8025.

:. Total Fixed cost = Maintainces cost + scrapper cost. sludge pump cost mixing tank cost

= 66441.36 + 18974.69 + 50,000 + 3780.8025

=N139196.85

5.2 VARIABLE COST

5.2.1 Power Consumption (Electricity)

Power Consumption = 10Kwatts/ day

NEPA Charge = 4.2 KW/day

cost = 4.2 x 10 x 366

= N15372

5.2.2 LABOUR

The minimum wages is N 7,000/month

Therefore minimum wages per annual is N7,000 x 12

= N84000

= **N84000**

∴ Variable cost = power consumption + labour cost

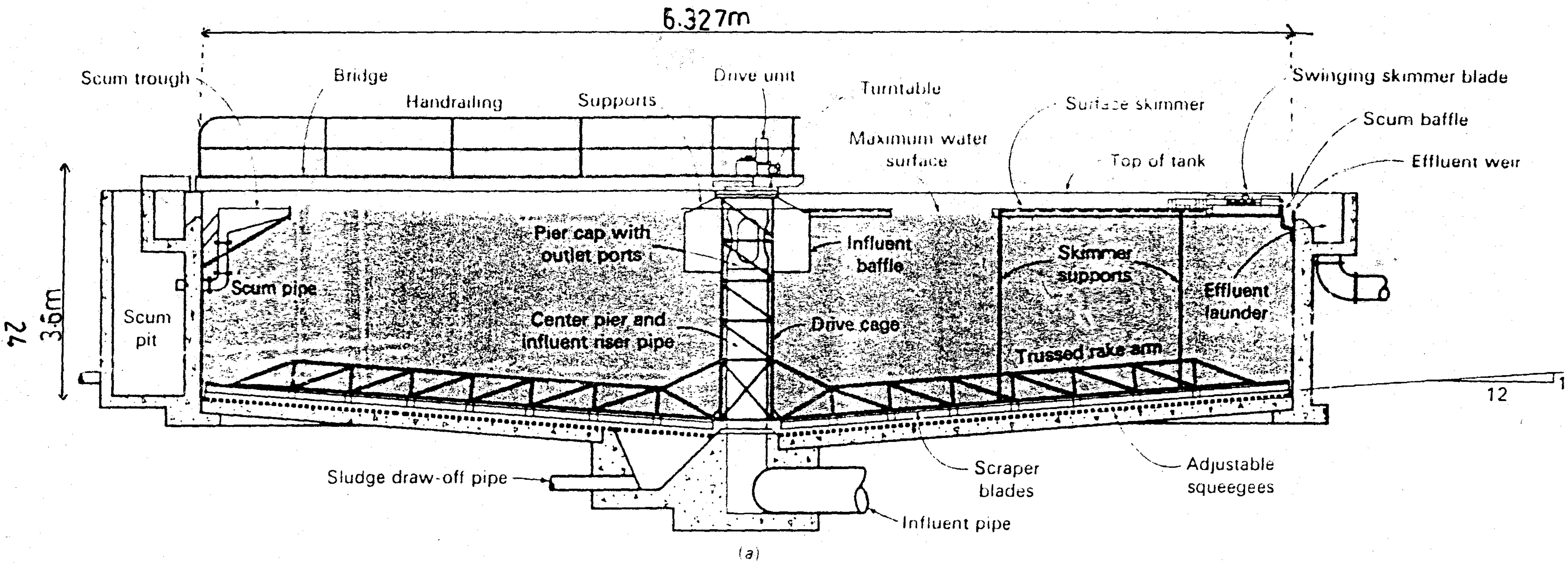
= N 84000 + N15372

=N99372.

∴ THE TOTAL COST = Fixed cost + Variable cost

= N139196.85 + N99372

=N238,568.85



(a)

FIGURE 3.

Typical circular primary sedimentation tanks: (a) center feed (from Infilco Degremont).

CHAPTER SIX

6.0 SAFETY AND QUALITY CONTROL

6.1 SAFETY IN WASTE WATER TREATMENT PLANT

During the treatment of the waste water from plant, the following safety should be take note

6.1.1 CHEMICAL SAFETY

The overdosing of chemical should be avoided, this can lead to high concentration of chemical in the waste water which can change chemical composition of the sludge.

The residual chlorine should not exceed 0.3mg/m^3 to prevent over concentration of chlorine in the water which can killed some biological organism in the sludge.

During the change of chlorine cylindrical, the mask should be wear because chlorine is poisonous to the human body.

Precaution should be taking during the cleaning of sedimentation in tank to avoid falling on it.

Primary settle tank should be constructed by concrete or PBC to prevent rusting.

Save notice should be placed at a dangerous section

6.1.2 ELECTRICAL SAFETY:

Electrical shock can be avoided if necessary precautions are observed by any person that working on an electrical/equipment in the plant. Amongst such precautions are the following.

- Do not forget to put off the main switch and take away the fuse carrier along while working on an installation.
- Do not forget to earth all metallic covering of the electrical wiring installation; to reduce as much as possible, amount of current available for passage through the human body in the event of occurrence of current leaking from the life conductor to the earth.
- Do not disconnect or plug point on an energised equipment or installation by pulling a flexible cable.

To Avoid Fire Risks the following faults should be take note

- Avoid overloading,

- Avoid short-circuit
- Earth all the Appliance
- Tight connection

6.1.3 MECHANICAL SAFETY

To guard against traumas and accidents, factory worker should be instructed and taught safety precaution, introduced to various industrial hazards in every section of the factory.

- The machine should not exceed specified maximum operating condition.
- It is essential that first aid equipment is available and that the supervisor know how to use it.
- Walking Bridge should be placed on top of the primary and secondary settling tank, to avoid falling on it.

6.2 QUALITY CONTROL

6.2.1 WATER SAMPLE ANALYSIS

Water Quality analysis test for the water sample analysis. The required tests on the collected water samples are physical test, to confirm the existence of the physical parameters (pollutant in the respective water samples: chemical test, to confirm the presence of the chemical parameters (pollutant) in the respective water sample; and the bacteriological examination to confirm the presence of the coliform bacteria in the respective water samples that denote the potential presence of intestinal pathogens.

6.2.2 PHYSICAL PARAMETERS

The physical parameters that are usually evaluated for the collected samples test under the laboratory test are as follows conductivity, temperature, turbidity, colour and TDS(Total Dissolved Solids). Taste and odour, all these were measured with the aid of their corresponding sensitive instrument.

6.2.3 CHEMICAL PARAMETERS

The chemical parameters that are usually test under the laboratory test of waste water sample are; Nitrate, Manganese, Floride, Iron, fresh chlorine, PH , chloride, hardness (calcium and magnesium) and sulphate.

6.2.4 **BACTERIOLOGY PARAMETER**

It is the one of waste water quality analysis and if the carried out to examine the quality of bacteria that are present in the waste water before and after treatment.

The fundamental techniques concerning the bacteriological examination were:

i. The multiple tube technique (known as the most probable number (MPN)

ii. Total viable bacterial count.

The most probable number (MPN) method requires three consecutive stages in which the out come of each stage predict the running of the next stage the three stages involved are, the Presumptive test, the confirmed test and the completed test.

a. Presumptive Test: This process is use to estimate the number of bacterial that present on sewage water and determining the presence of coliform bacteria in water sample under analysis.

b. Confirm Test: this process is to test coliform bacterial, in the water samples showing a positive presumptive tests this process is necessary, since positive presumptive test may be the result of organism of non-coliform origin that are not recongnised as indicators fecal pollution.

c. Complexed Test: this is the final analysis of the water sample under the multiple tubes technique and if examines, the coliform colonies that appeared on E.M.O W. maccon key agar plates used in the conformed test.

d. Total Viable Count: this is to determine the total number of viable bacteria in water sample. It is useful supplementary test, although of limited values by itself. It gives an indication of the amount and type of organic matter present in the water supply. In any case, the test does not give detailed information as if the bacterial is pathogenic or not.

CHAPTER SEVEN

7.0 SITE FOR PLANT LOCATION AND ENVIRONMENTAL ACCEPTABILITY

7.1 SITE FOR PLANT LOCATION:

7.1.1 URBAN/ INDUSTRIAL AREA:

Plant site should be located at the extreming end of the waste water way.

7.1.2 WASTE WATER AREA:

The availability of waste water will often determine the site location. Plant treated waste water are best located close to the sources of the waste water way.

7.1.3 TRANSPORT:

The plant should be located where there is possible construction of pipe line for the disposal of treated waste water.

The transport of sludge from the plant will be an over riding consideration in site location near road, so that, sludge will be easily transport from one place to another by motor.

7.1.4 AVAILABILITY OF LABOUR:

Labour will be needed for construction of the plant and its operation skilled construction worker will usually be brought in from outside the site area; but there should be an adequate role of unskilled labour available locally; and labour suitable for training to operate the plant skilled tradesman will be needed for plant maintenance.

7.1.5 UTILITIES (SERVICES):

The plant should be located near there is supplies of electricity, because Electrical Power will be need for plant operation.

7.1.6 **ENVIRONMENTAL IMPACT AND EFFLUENT DISPOSAL:**

Plant should be located where sludge disposal will be dispose after treatment.

7.1.7 **LAND (SITE CONSTRUCTION):**

Sufficient suitable land must be available for proposed plant and for future expansion. The land should ideally be flats will drained and have suitable land bearing characteristic.

A full site evaluation should be made to determine the need for piling or other special function.

7.1.8 **CLIMATE:**

Adverse climate condition at a site will increase costs. Abnormally low temperature will require the provision of additional insulation and special heating for equipment and pipe runs stronger structures will be needed at location subject to high wind or earthquakes.

7.1.9 **POLITICAL AND STRATEGIC CONSIDERATION:**

Capital grants, tax collection and other inducement are often given by government to direct new investment to preferred location; such as area of high unemployment. The availability of such grants can be the over riding consideration.

7.1.10 **SITE LAYOUT**

The layout of the plant can be found at appendix of this thesis.

7.2.0 **ENVIRONMENTAL ACCEPTABILITY**

Gases in waste water and other unventilated or confined spaces associated with sewage systems may be poisonous as asphyxiating or explosive. The poisonous and asphyxiating gases include Carbon monoxide, Carbon dioxide, chlorine and volatile gases from industrial wastes entering the sewer. The explosive type, which may also burn, include hydrogen sulfide, hydrogen and combination of various sewer gases.

An oxygen enriched atmosphere (above 21%) will cause flammable materials, such as clothing and hair to burn violently when ignited.

Therefore, location of plant is considered, to reduce synergetic effects of there hazardous chemicals. As a result of this, the plant is located far away from the residential area and also, fire alarm and fire fighting (water, CO_2, and dry powder). Are all in place.

To make this design environment friendly,

1. There must be proper control of odour, by proper cleanliness of the plant and good house keeping at all treatment units or bu using odour-masking or odour modification compounds.
2. Oxygen as injected compressed air, or as aspired (air alone or in conjuction with hydrogen peroxide), and commercial oxygen are used in sewers and force many to neutralized sulfide and prevent sulfide build up.
3. Sludge incineration with exhaust gas temperature of (816 - 817^{0}c) is necessary to effectively oxidize or burn off the offending odour.

CHAPTER EIGHT

PROCESS CONTROL AND INSTRUMENTATION

The primary objectives of the designer when specifying instrumentation and control schemes are:

i. Safe Plant Operation

(a) To keep the process variables within known safe operating limits.

(b) To detect dangerous situations as they develop and to provide alarms and automatic shutdown systems.

(c) To provide interlocks and alarms to prevent dangerous operating procedures.

ii. Production rate: to achieve the design product output

iii. Product quality: to maintain the product composition within specified quality standards.

iv. Cost: to operate at the lowest production cost, commensurate with other objectives.

8.1 CONTROL

In a typical chemical processing plant these objectives are achieved by

a combination of automatic control, manual monitoring and laboratory analysis.

The procedures used when drawing up preliminary control and instrumentation diagram are:

1. Identify and draw in these control loops that are obviously needed for steady plant operation such as

(a) Level controls

(b) Flow controls

(c) Pressure controls

(d) Temperature controls

2. Identify the key process variables that need to be collected to achieve the specified product quality. Include control loops using direct measurement of the controlled variable where possible, if not practicable, select a suitable dependent variable.
3. Identify and include those additional control loops required for safe operation.
4. Decide and show those ancillary instruments needed for the monitoring of the plant operation by the operators and for troubleshooting and plant development.
5. Decide on the location of sample points and the need for recorders and the location of the readout points, local or control room.
6. Decide on the alarms and interlocks needed.

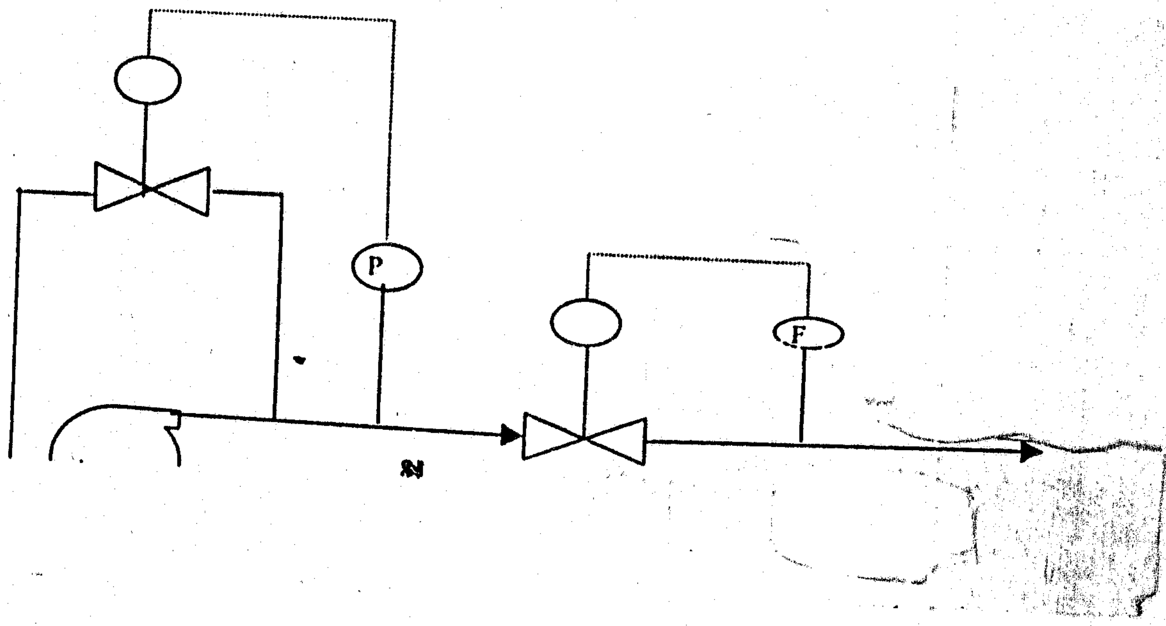
8.2 INSTRUMENTATION

Instruments are provided to monitor the key process variables during plant operation. They may be incorporated in automatic control loops, or used for the manual monitoring of the process operation. Instruments monitoring critical process variables will befitted with automatic alarms to alert the operators to critical and hazardous situation.

8.3 CONTROL SYSTEM

8.3.1 STORAGE TANK CONTROL

Flow control is needed to maintain a constant output from the storage tank or other equipment.



CHAPTER NINE

PLANT START-UP AND SHUTDOWN

This must proceed safely and be easily flexible enough to be carried out in numerous ways. The operating limits of the plant must not be exceeded though control systems may be operating out of their normal range. Mechanical, electrical and instrumentation fault, wrong use of flowsheets, poor or incorrect isolation of subsystems are apt to occur during either start up or shutdown mode.

This may lead to additional of new equipment where necessary and will indicate on the engineering line diagram. Contaminants often enter the system at this stage, these as well as the unconverted materials are not tolerated in part of the system, and so clean material may be needed for start-up.

Start-up or shutdown of plant may increase the requirement for chemicals as well as utilities. The effluent and relief systems should be able to cope with large or abnormal discharge at such times. Where inert material may be required urgently, the system must be available (e.g. water, steam) and therefore must be permanently connected to provide adequate single capacity. Non-return of values should be fitted where there is any possibility of reverse flow.

9.1 EMERGENCY SHUTDOWN OF PLANT

This may be due to breakdown of any of the major equipment, which is not easily replaceable, for instance the distillation column.

It may also be due to shortage supply of quality raw material or a particular product of lower quality is been produced and there is need to clean up the reactor before producing any other quality. Abnormalities in the supply of the utilities may also cause emergency shutdown of the plant.

When there is an emergency the process must be returned to a safe condition. A special

Plant process trip system is designed to effect the emergency shutdown of plant, when this becomes necessary. A trip system carries out the appropriate activity on command either from automatic actuation of a relay. Such system are closely associated with the shutdown of plant when some unit partially working in this manner, time is saved during the start-up of plant and hazards such as ingress of air may be avoided.

...down can be designed to partition the plant into different segments such as operating utility or according to pressure, level or volume of flammable material. Thus it will be possible to reduce the volume of fluid that can be spilled in the event of a pipe rupture or the liquid flow resulting from differential pressure.

Alarm should indicate which trip has been activated or warn of the imminent danger of plant being closed down if action is not taken by the operators to reduce this risk.

Trip system should be reliable and operate only when required, thereby avoiding a nuisance shutdown of plant. When needed they must not fail. The trip setting should be at a conservative level to give a generous margin of safety.

Emergency power supply must be considered in conjunction with the shutdown system. B DC power source may be provided for the shutdown system and for such equipment as is critical to a the plant's safe operation during operation shutdown.

9.2 START-UP AFTER EMERGENCY

When the trip system is being designed, each start-up must be undertaken with care. It is necessary to consider what happens when the trip occurs and when the trip condition is removed. The necessary actions are planned for all those cases, which can be foreseen.

9.3 GENERAL MAINTENANCE CONSIDERATIONS

All equipment, pipework, instrumentation alarm requires maintenance and inspection. The main safety features in preparing plants for maintenance are making safe, either by purging or by ventilation, to vapour concentrations well below the lower explosive limit in air or other appropriate level.

Where work must be carried out in conformed spaces, attention must be given to some specific units. If maintenance is carried out while the system is in operation, appropriate facilities must be provided and the procedure must not be allowed to create a hazard within the system. Block values are usually sufficient for initial isolation of streams. Dual values assist in the safe reduction of pressure. It is most desirable that all material should drain and not remain in crevices and pocket of provision of independent instrumentation or other facilities for checking that equipment has drained, is also important. The effluent resulting from maintenance must be checked carefully for safety.

CHAPTER TEN

10.0 CONCLUSION/RECOMMENDATION AND FLOWCHART

10.1 CONCLUSION:

Waste water if not treated before discharge to the sea or land could be very toxic and harmful to the lives of plants and animal (human being inclusive). The incorporation of an electrolytic cell into the treatment plant will enhance a better treatment has some heavy metals which would have accumulated in water or soil are being taken of before discharge.

The major advantage of this method is that sludge recovered from could be reused or sold since they are obtained in pure form. The area of tank is $1257.74m^3$, diameter is 12.65m, volume of sludge is $2.492m^3/1000m^3$.

10.2 RECOMMENDATION

Based on the design work, I hereby recommend that:

1. More attention should be given to effluent treatment so that the water is recycled rather than being discharge.
2. Then unity such as screening and disposal unit should be incorporated into the treatment plant to enhance better purity of water .
3. Further research should be carried out to ensure the process is not cost intensive.
4. Government should enforce effluent treatment policy on all those such production.

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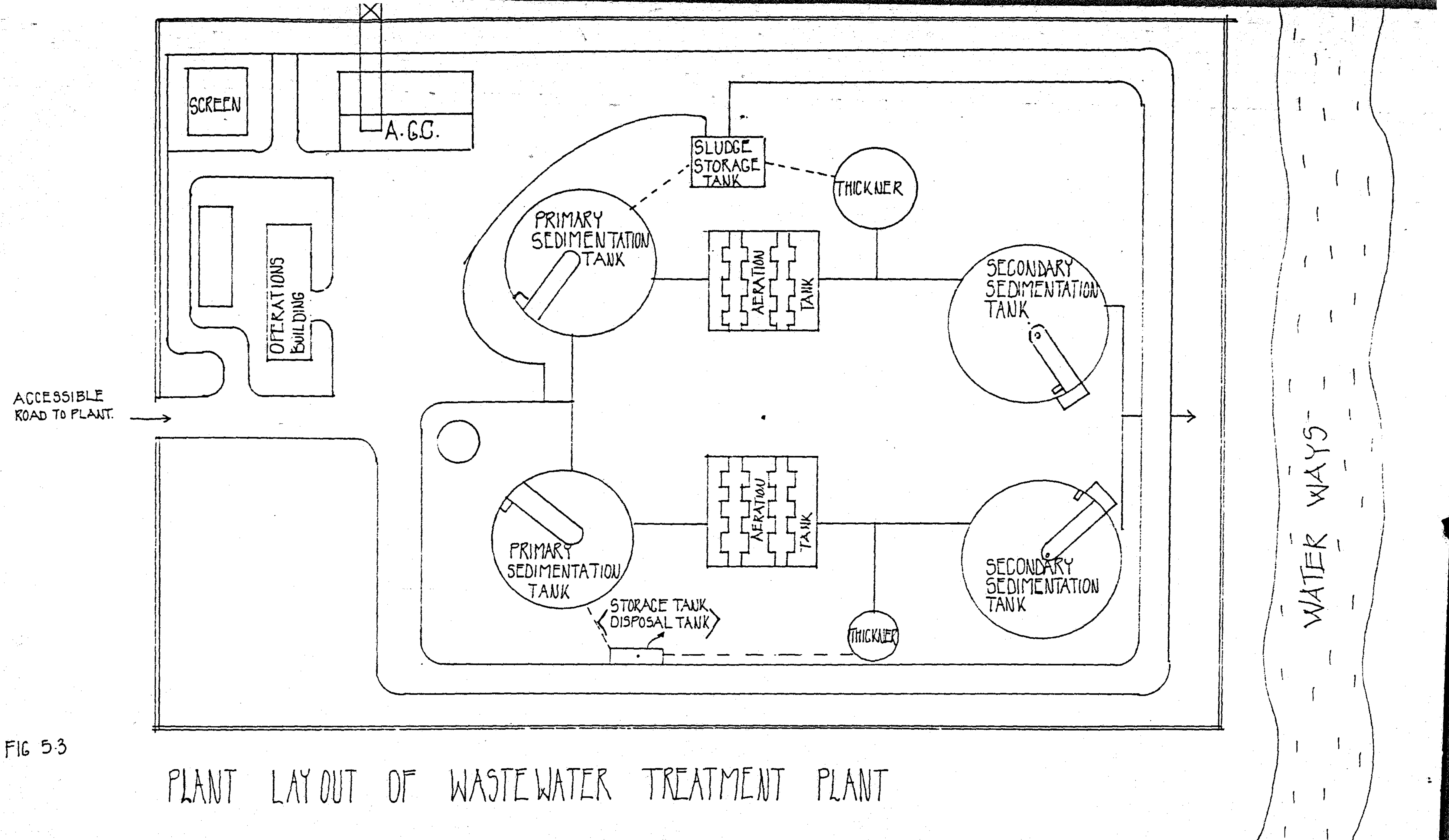

FIG 5.3

PLANT LAYOUT OF WASTEWATER TREATMENT PLANT