TREATMENT OF WASTEWATER FROM FISHPOND USING AERATED LAGOON

BY

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DEPARTMENT OF AGRICULTURAL ENGINEERING,

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MINNA, NIGER STATE.

NOVEMBER, 2006

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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN AGRICULTURAL ENGINEERING.

DEPARTMENT OF AGRICULTURAL ENGINEERING,

FEDERAL UNIVERSITY OF TECHNOLOGY,

MINNA, NIGER STATE.

NOVEMBER, 2006

DECLARATION

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 Information derived from personal communication, published and unpublished works of others were duly referenced in the text.

....
Akinyemi, Banjo Ayobami

03-11-06
....
Date

CERTIFICATION

This Project entitled "Treatment of Wastewater from Fish Pond using Aerated Lagoon" by Akinyemi B. A. meets the regulations governing the award of Bachelor of Engineering (B.ENG) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

06/11/06 ------------------------------------ 06-11-06
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Date

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Date

DEDICATION

This project is dedicated to my loving Mother, Mrs. Elizabeth M. Akinyemi for her support and care because without you I wouldn't become a graduate today. I'm also dedicating this work to my adorable sister and her charming husband, Mr. and Mrs. Osunmakinde for their kind gestures and prayers. And finally to my great Uncle, Mr. Seun Olowe for being a brother I never had, God bless you all. Amen.

ACKNOWLEDGEMENT

I thank God for His infinite mercy, goodness, protection and favour since I was born and making me to be alive to witness this day.

My profound gratitude goes to late Mohammed Bashir, who was my former project supervisor before his life was cut short untimely, his contributions to my project cannot be undermined. May God grant him eternal rest.

I equally wish to recognize the encouragement and invaluable assistance accorded to me by my new supervisor, Mr Peter Adeoye, I pray that God will bless you in all your endeavours.

Also I wish to acknowledge the contributions of the following lecturers Mrs. Asana Mustapha, Engr.Dr.N.A.Egharevba, Engr.Dr.(Deacon).O.Chukwu, Mr Fabunmi and all the other staff of the department not mentioned here.

My friends also Engr.Orayemi Mohammed,Maji Nath,Otunba Mayor,Owolabi Kunle,Joel.Ote.com,Amos,Osisienato and the rest all of Agricultural Engineering Department.

Finally, my deep appreciations to Kanmi Afolabi for being a good friend, my Grandmother Mrs. Felicia Olowe and all other individuals not mentioned that have in one way or the other been a source of help and inspiration to me. I say God bless you all, Amen.

ABSTRACT

Wastewaters from fishponds was collected and analysed to ascertain its physical, chemical and biological properties. This is done with a view to knowing how feasible it would be to treat it biologically. The sample was subjected to laboratory analysis. The results show that the water before it entered the fish pond (weir) was clean but becomes polluted by the metabolic activities of aquatic organisms. The total dissolved solids (TDS) of about 156 mg/l and temperature of 32^oC were got from physical parameters. From the chemical analysis, the water has quite appreciable amount of nitrate, phosphate and potassium. They are, 16.4 mg/l, 5.61 mg/l and 2.81mg/l, respectively. The water would have been therefore useful for irrigation purposes at the downstream end but for the high concentration of copper, iron, boron and manganese which are 1.70 mg/l, 0.12 mg/l, 1.20 mg/l and 0.04 mg/l, respectively. This if not treated will lead to salinity of the soil. Biochemical oxygen demand (BOD) and four hour permanganate values (PV_4) were compared and since the ratio is more than 3.5 (220:32); biological treatment is feasible. Based on this 57.12m^3 sedimentation tank to reduce suspended solid and TDS was designed. And (2.5 x 10 x 16) m^3 of aerated lagoon was also designed to use diffused air aerators. This, if constructed will treat the wastewater and make it fit for recyclelatory system or for irrigation purpose since the toxic elements would have been diluted by aeration process. Even, if the water is to be diluted to the nearest watercourse, it will not create any nuisance because the BOD/DO values would have conformed to 20/30 WHO and APHA standards.

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CHAPTER ONE

INTRODUCTION

Fish benefits people in different and many ways. Fish make up a major part of human diet. In other countries, people eat fish to add variety to their meals. Fish are also, important in the balance of nature. Fish rank among the most nourishing of all foods. Fish flesh contains about as much as protein as meat does. The majority of freshwater fish are raised in ponds. Water is taken from a lake, bay, well or other natural source and is directed into the pond. Fishpond range in size from a few squares meters to several hectares. In general small ponds are used for spawning and fingerling production. The water either passes through the pond once and is discharged or it may be partially retained so that a certain percentage of the total water in a system is conserved.

Agricultural wastewater may be defined as the combination of the liquid carried wastes from institutions, residences and commercial and industrial establishments. Untreated wastewater usually contains numerous pathogenic organisms that may be present in certain industrial waste. It also contains nutrients, which can stimulate the growth of aquatic plants and may also contain toxic substance. For these reasons it is necessary to treat wastewater. However because of increased water consumption which may lead to the reduction in volume of water supplied to fishponds. Since water is also a basic need for human beings, more and more people compete for the same resource, which then creates problems for the fish farmer. These problems can then be tackled efficiently by the use of recycling aquaculture system. Most fish production takes place in outdoor ponds where production success is often subjected to such natural occurrences as weather, the presence of aquatic weeds and predation by birds and other animals The recycling aquaculture system removes some of the inefficiencies found in production system. Water reuse reduces pumping costs and retains energy normally used to heat water. In addition, it enables production to occur in a controlled environment where losses to predators and seasonal drought do not influence production plans. It also permits a reduction in water consumption and the production of large numbers of fish in a small area It also maintains an excellent cultural environment while providing adequate feed for optimal growth. Maintaining good water quality is of primary importance in aquaculture. Critical water characteristics include concentrations of dissolved oxygen, un-ionized ammonia, nitrogen, nitrate concentration, pH, and chloride levels.. The by-products of fish metabolism include carbon(iv)oxide, ammonia-nitrogen, particulate and dissolved feacal solids. Water treatment components are designed to eliminate the adverse effects of these waste products. In wastewater treatment systems, proper water quality is maintained by pumping pond water through special filtration and aeration (oxygenation) equipment. Each component so designed to work in conjunction with other components to bring about the reduction in toxic substances in the water before being discharged.

1.1 Backgound of the Project

This project describes how to treat water from fishponds. The water coming from the culture tank contains high concentrations of dissolved oxygen, ammonia, pH, settleable solids, and suspended solids The by-product of fish metabolism include carbon-(iv)oxide,ammonia-nitrogen, and dissolved feacal solids.

1.2 Statement of the problem

Water supply is the most important factor to be considered before the construction of fishponds. Fish needs water for breathing, eating, growth and to reproduce. Large quantities of water must be available all year round for the fish and lack of it in adequate quantity creates a problem, which can be easily solved by the recirculation of already used water in the production system of fishpond.

1.3 Objectives of the Project

The objectives of this project are:

(i). To determine the physiochemical and bacteriological properties of wastewater from a fish farm.

(ii) .To establish the parameters that are detrimental to the environment from the wastewater and

(iii) Design a treatment system that will remove the harmful parameters from the fishpond wastewater.

1.4 Justification and Scope

The earlier stated problems like shortage of water supply, climatic conditions, presence of aquatic weeds and predation by birds and other animals can be solved by using biological wastewater treatment system like sedimentation tank and aerated lagoon. Therefore this project can be justified. From the analysis of the waste water got, the toxic level can be effectively lowered through the use of a treatment tank or lagoon to reduce the waste water parameters to an acceptable level as recommended by W.H.O (1995) and APHA(1995) However the farmer could not afford to pay for the construction treatment system now and since the surrounding communities have not complained about any nuisance being created by wastewater, the system could not be constructed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Fish and its Benefits to Man

Fish are vertebrates that live in water. There are more kinds of fish than all kinds of water and kind of vertebrates put together. Fish can be found anywhere there is water. Scientists believe fish are the first animal to have a backbone and that the first fish appeared on the earth about 500million years ago (The World Book Encyclopedia, 1993). From the smallest fish called Trimmaton nanus(Indian Ocean,1cm long)fish varies in size to the largest fish whale shark (of 12m long)weighing twice as an elephant. There is also in existence the dangerous fish (poisonous spines that can kill a human being in a matter of minutes) to mention a few.(World Book Encyclopedia ,1993)

Fish benefits man in many ways. Fish rank among the most nourishing of all foods. Fish flesh contains as much protein as meat does (FAO and NSPDF, 2005) Pond is a small quiet body of water that is usually shallow enough for sunlight to reach the bottom. Ponds support a great variety of animals and plant life. Pond animal may include fish, frogs, insects, and birds. Kinds of natural ponds include, alpine ponds, bog ponds, ice –formed ponds meadow stream ponds, riverine ponds, sinkhole ponds e.t.c. (FAO and NSPDF, 2005) Many farmers build a farm pond for flood control, recreation or to secure a supply of water. Life in a pond is determined largely by the pond soil, quality of water and location. Ponds consistently undergo annual and long term changes. Water level normally rise and fall because of rainfall .Many natural processes help to maintain ponds, for example, floods and the movement of ice may deepen ponds. Animal activities on the other hand can seriously have harmful effect on ponds.

2.2 History of Fish Farming

World fish farming was first practiced as long as 2000 .B.C, in China. The Bible refers to fishponds and sluices (Isa19:10),and ornamental fishponds appear in paintings from ancient Egypt,(Swann, 1992) European aquaculture began sometime in the middle ages and transformed the "art "of Asian aquaculture into a science that studied spawning, pathology and food webs. One of the most significant developments was the invention of culture methods for trout, which were being introduced into natural waters by the mid-1800s (Swann, 1992). Aquaculture is a form of agriculture that involves the propagation, cultivation, and marketing of aquatic animals and plants in a controlled environment.(Bucklin, Baird and Watson, 1993) The history of aquaculture in the United states can be traced back to the mid to late 19th century when pioneers began to supply brood fish, fingerlings and lessons in fish husbandry to would-be aqua culturist. Until the early 1960s, commercial fish culture in the United states was mainly restricted to rainbow trout, baitfish and a few warm water species, such as the buffalo, bass and crappies. Many of these early attempts at fish husbandry failed because:

(i) operators were not experienced in fish culture

(ii) Ponds were not properly built.

(iii) low value species were being raised and

(iv) .selected species lacked adequate technical support.(Swann, 1992)

2.3 Types Of Aquaculture

Fish farming ranges from backyard subsistence ponds to large scale industrial enterprise. Farming systems can be distinguished in terms of input levels. In Extensive fish farming,(economic) inputs are usually low; natural food production plays a very important role and pond productivity is relatively low. Fertilizer may be used to increase pond fertility and thus fish production .In Semi-intensive fish farming, a moderate level of inputs is used an d fish production is increased by the use of fertilizer and or supplementary feeding. This means high labour, food costs and higher fish yields.

In Intensive fish farming, a high level of inputs is used and the ponds are stocked with as many fish as possible. The fish are fed with supplementary food, and natural food production plays a minor role. In this system there is high feeding costs and risks due to high fish stocking densities, which increases the susceptibility to diseases. .(William, 2001).

Also dissolved oxygen shortage can become a difficult management problem. Because of the high production costs, you are forced to fetch a high market price in order to make the fish farming economically feasible (FAO and NSPFS, 2005).

2.4 Types of Pond

Ponds may be classified either based on its use or by the method of construction.

(William, 2001).

Classification based on mode of use is of two types:

(i) Culture ponds and

(ii) Production ponds

While classification based on construction method are

(i) Diversion ponds and

(ii) Barrage ponds

Production ponds are normally located on lands with a gentle slope. They are rectangular or square shaped, have well finished dikes and bottom slopes and do not collect run off water from the surrounding water shed .It is important that sufficient water is available to fill all ponds within a reasonable period of time and to maintain the same pond water level (Adewoye, Adewuyi and Ajayi, 2005). The ponds should be drained comfortably and completely when the fish are to be harvested. Side slopes should be 2:1 or 3:1 which allow easy access, and will not encourage vegetation to grow and help to reduce erosion problems (FAO and NSPFS, 2005). To prevent fish theft, bamboo poles or branches might be put in the pond, which make netting and rod-and-line fishing impossible. Another method to keep thieves away from the fish pond is to locate it close to homes.

2.5 Pond Construction

Select land with gentle and layout slopes to take advantage of existing land contours. Ponds may be dug into the ground, they may be partly above and partly in the ground, or they may be below original ground elevation; slopes and bottom should be well packed during construction to prevent scouring and seepage; soil should contain a minimum of 25% clay. Rock, grass, branches of woods and other undesirable objects should be removed (Swann, 1992). Depth should be 0.5-1.0m at shallow end, sloping to 1.5-2m at the drain end: deeper ponds may be required in temperate regions where threat of winter-kill below deep ice cover exists.(Akeredolu,1991)

Inflow lines should be of sufficient capacity to fill each pond within 3 days; if surface water is used 'the incoming water should be filtered to remove undesirable plants or animals. Locate pond properly to take advantage of water mixing by the wind, or in areas where wind causes extensive wave erosion of dikes, place long sides of pond at right angles to the prevailing wind; use hedgerows or tree wind breaks when necessary. (Baluyut, 1989) Depending on the site, fish ponds may be diversion or barrage ponds: Diversion ponds are made by bringing water from another source to the pond. There are different types of diversion ponds, embankment ponds, excavated ponds and partially excavated ponds with low dikes. Barrage ponds: are made by building a barrier across a natural stream. The ponds are therefore like small conservation dams. The advantage of this is that it is easy to construct. However, it is very difficult to control. It is also difficult to keep wild fish out and a lot of food added to the pond will be lost because of the current of the stream.

A properly built barrage pond (with outflow) overflows only occur under unusual circumstances. (Akeredolu, 1991).

2.6 Constituents Found in Wastewater

2.6.1 Physical Constituents

The most important physical characteristics of wastewater is its total solids content which is composed of floating matter, settleable matter in solution. Odour, temperature, colour and turbidity. Odours in fishpond wastewater are usually caused by gases produced by the decomposition of organic matter or by substances added to the wastewater. Fresh wastewater has a distinctive, somewhat disagreeable odour, which is less objectionable than the odour of wastewater that has undergone anaerobic decomposition. Industrial wastewater may contain either odourous compounds or compounds that produce odours during the process of wastewater treatment.(Hammer,1992)

The temperature of wastewater is commonly higher than that of the water supply because of the addition of warm water from industrial activities. The temperature of water is a very important parameter because of its effect on chemical reactions aquatic life, and the suitability of the water for beneficial uses. Increased temperature for example can cause a change in the species of fish that can exist in the receiving water body. . (Hammer, 1992)

In addition, oxygen is less soluble in warm water than in cold water .The increase in the rate of biochemical reactions that accompanies an increase in temperature, combined with the decrease in the quantity of oxygen present in waters, can often cause serious depletions in dissolved oxygen concentrations.(Abiola,1995).

COLOUR: The term "condition" was used along with composition and concentration to describe wastewater. Condition refers to the age of the wastewater, which is determined qualitatively by its colour and odour. Fresh wastewater is usually a light brownish-grey colour. But as the travel time in collection system increases, and more anaerobic conditions develop, the colour of the fishpond wastewater changes from grey to dark grey and ultimately to black (APHA, 1995).

Turbidity: is a measure of the light transmitting properties of water; it is another parameter used to indicate the quality of waste discharges with respect to colloidal and residual suspended matter. (Hammer, 1992).

2.6.2 Chemical Characteristics

This comprises of organic matter, inorganic matter and. Gases.: In a wastewater of medium strength, about 75% of the suspended solids and 40% of the filterable solids are organic in nature. These organic matters are proteins, carbohydrates, fats and oils and urea. Wastewater contains small quantities of a large number of different synthetic organic molecules like surfactants, organic priority pollutants, and volatile organic compound e.t.c. .(Hammer,1992) The inorganic constituents of wastewater are the hydrogen-ion concentration in solution measurement (pH). From a practical consideration, pH gives us a relative comparism of the degree of acidity or alkalinity of a solution. A neutral solution has a pH of 7.0 and a basic solution has a pH greater than 7.0.

The pH of water can directly affect the fish and other organisms living in that water and also has many indirect effects. Most aquatic species prefer a pH of about neutral to slightly basic. Ammonia is more toxic at higher pH levels and less toxic at lower pH levels. The toxicity of ammonia increases ten fold for every 1.0 increase in pH above 7.0.The biological filter in a treatment produces acid when it is working properly, so pH needs to be continually assessed and adjusted to ensure good water quality.

Optimal pH levels for most fish are in the range of about 7.0 and 9.0.The pH in a treatment system should however, be kept in the range of about 6.8 to 7.2

ALKALINITY: This is defined as the total of all of the bases (bicarbonate and carbohydrate) in water. Alkalinity serves two very important functions in treatment system. The equilibrium of carbon (IV) oxide, bicarbonate and carbonate in water serves as the effective means to keep the pH close to neutral. As acid is added to the system from the biological filter, the acid is neutralized by the bicarbonate in the water. This neutralizing property is called buffering and it prevents large shifts in system pH.

The alkalinity in a treatment system should be maintained between 150 to 200mg\l as $CaCO_3$.

NITRITE: Nitrite(NO_3) is an oxidized form of nitrogen that is a by product of the nitrification process in the biological filter. Nitrite is further oxidized in the biological filter to form nitrate(NO_3),which is relatively non toxic to the fish.

Nitrite is highly toxic to fish. Elevated levels of it will interfere with the fish blood's ability to transport oxygen. During the start up of a biological filter, Changes in metabolic rates of the fish can also affect the dissolved oxygen levels in the treatment system. These metabolic rate changes are a function of water temperatures and fish activities.

Dissolved oxygen levels should be kept as close to saturation as properly. A properly designed oxygenation system will have sufficient capacity to meet the demands of the fish and other consumers in the treatment system.

AMMONIA: It is a metabolic byproduct of fish in the system. The fish consume food and excrete ammonia directly from their gills and in their faeces.As feacal matter breaks down in the system, more ammonia is released. Ammonia is present in water in two forms. Ionized ammonia (NH_4) is one of the forms and it is relatively non-toxic to fish.Un-ionized ammonia (NH_3) is the other form and it is highly toxic or at least stressful to fish at relatively low levels.

The relative proportion of NH_4 to NH_3 is governed by other chemical factors in the water. Temperature, pH, salinity all affect the relative proportion of NH_4 to NH_3.

A properly designed system will have sufficient biological filtration capacity to maintain ammonia al levels that are minimally stressful to the fish.(Hochheimer,2005).

2.7 Fish Pond Wastewater Treatment Method

2.7.1. Oxygen Transfer.

Oxygen transfer is the process by which oxygen is transferred from the gaseous to the liquid phase. It is a vital part of a number of wastewater treatment processes. The functioning of aerobic processes, such as activated sludge, biological the treatment system. These metabolic rate changes are a function of water temperatures and fish activities.

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Oxygen transfer is the process by which oxygen is transferred from the gaseous to the liquid phase. It is a vital part of a number of wastewater treatment processes. The functioning of aerobic processes, such as activated sludge, biological filtration, and aerobic digestion, depends on the availability of sufficient quantities of oxygen.

The most common application of oxygen transfer is in the biological treatment of wastewater. Because of low solubility of oxygen and the consequent low rate of oxygen transfer, sufficient oxygen to meet the requirements of aerobic waste treatment does not allow the entrance of water through normal surface air-water interface. To transfer the large quantities of oxygen that are needed, additional interfaces must be formed. Either air or oxygen can be introduced into the liquid, or the liquid in the form of droplets can be exposed to the atmosphere.

Oxygen can be supplied by means of air or pure oxygen bubbles introduced to the water to create additional gas-water interfaces. In wastewater treatment plants, submerged-bubble aeration is most frequently accomplished by dispersing air bubbles in the liquids at deep depths under the water (Hammer, 1992).

2.7.2. Aeration System

DIFFUSED-AIR AERATION: The two basic methods of aerating water are:1. To introduce air or pure oxygen into the wastewater with submerged diffusers or other aeration devices or. 2. To agitate the wastewater mechanically so as to promote solution of air from the atmosphere. A diffused-air system consists of diffusers that are submerged in the wastewater, header pipes, air mains, and the blowers through which the air passes.

Diffusers can be categorized by the physical characteristics of the equipment. These are:

1. Porous or fine-pore diffusers e.g. fine bubble system
2. Non porous diffusers e.g. coarse bubble system
3. Other diffusion devices such as jet aerators, aspiring aerators e.t.c

MECHANICAL AERATORS: Mechanical aerators are commonly divided into two groups based on major design and operating features: aerators with vertical axis and aerators with horizontal axis. Both groups are further subdivided into surface and submerged aerators. In surface aerators, oxygen is entrained from the atmosphere ands for some types, from air or pure oxygen introduced in the tank bottom. In either case, the pumping or agitating action of the aerators helps to keep the contents of the aeration tank or basin mixed.

Surface mechanical aerators with vertical axis are designed to consist of submerged or partially submerged impellers that are attached to motors

Mounted on floats or on fixed structures. Fiber-glass reinforced plastic are used to agitate the wastewater vigorously ,entraining air in the wastewater and causing a rapid change in the air-water interface to facilitate solution of air.

Submerged mechanical aerators with vertical axis or pure oxygen are introduced by diffusion into the wastewater beneath the impeller. The impeller is used to disperse air bubbles and mix the tank contents.(Hammer,1992).

2.8. Environmental Effects of Discharge of Effluents from Fishponds

2.8.1 Pollution

1. Pond water discharged into water courses adversely affects sedimentation rates, the nutrient cycle and dissolved oxygen levels of the streams. These changes can lead to a state where water body is polluted with excess nutrients, which remove dissolved oxygen from the water and cause rapid plant growth including toxic algal boom which concentrate in fish, thereby causing serious risk to human health.

2. Excess food is consumed by bottom dwelling organisms or is left to decompose. Decomposition causes degradation of water quality and decreasing oxygen levels in the water body, which is fatal to aquatic organism.

3 Fish wastes from intensive aquaculture in combination with decomposing excess food also cause algal boom.

4. Human activities like human wastes associated with aquaculture also generate pollution if generated from habitation near fishponds can degrade water quality and create hazards.

2.8.2 Habitat Destruction

Mangroves stabilize coastlines, reduce storm erosion, act as spawning and nursery areas for many fish and crustaceans, they also support a diverse population of grasses, birds e.t.c.Mangroves also serve as a renewable resource, providing fire-wood ,timber, pulp and charcoal for local communities. Destroying mangroves has a disastrous effect on the environment. Wetlands are often converted to aquaculture ponds. This results in flooding and loss of animal habitats, and adversely affects downstream water quality.

2.8.3 Impacts on Freshwater Sources

Pond water is often discharged into freshwater bodies, adding excess nutrients and pollutants increasing salinity. Salt can also seep into freshwater from poorly designed treatment sites.

2.8.4 Adverse Impacts on Downstream Users

Seepage and discharges from fishponds can degrade the quality of water available to downstream users, affecting drinking water, agriculture, capture fisheries and recreational users of water bodies (Hochheimer, 2005).

CHAPTER THREE

METHODOLOGY AND MATERIALS

3.1. Study Area

The water samples used for this project were taken from Sheshi Integrated farms located in Katcha town in Niger state. The farm is situated on the outskirts of the town and along the road that leads to Agae town. It is located along Km 2 Katcha-Bakeko-Badeggi road with a longitude of 6.4° east and latitude of 9.7° north.

Sheshi Integrated farms limited is owned by a royal family in Katcha town, the family's name is Sheshi.The administrators and directors are the direct descendant of Sheshi himself, the farm managers and labourers are all employed to work within the farm itself. The farm consists of arable land where crops are grown, livestock section, poultry section and fishpond section.

Majority of the people living in Katcha town are farmers by occupation and few ones are civil servants. The civil servants also during their free days engage in farming practices with their whole household fully involved in it. The town makes use of the flowing stream for washing, household use and micro irrigation They get their drinking water from boreholes dug around the town which litters the whole place.

3.2. Sample Collection

Collection of water sample for examination was made in five(5) clean sterilized empty ragolis water containers. Water sample was taken at two fishponds adjacent to each other, another sample was taken at the weir, one sample also taken at the central discharge point into the stream.

Before filling the containers with water, some quantity of the sample was used to rinse the container then followed by the process of filling the containers themselves with their respective samples:

The five(5) bottles were labeled A,B,C,D and E.,where

A = Sample from weir

B = Sample from fishpond 1

C = Sample from fishpond 2

D = Sample from central discharge column

E = Sample from discharged water into the stream

Since it was not possible to start processing the samples immediately, the samples collected were well covered and taken to the laboratory to be processed and analysed. The following plates shows how the samples were collected

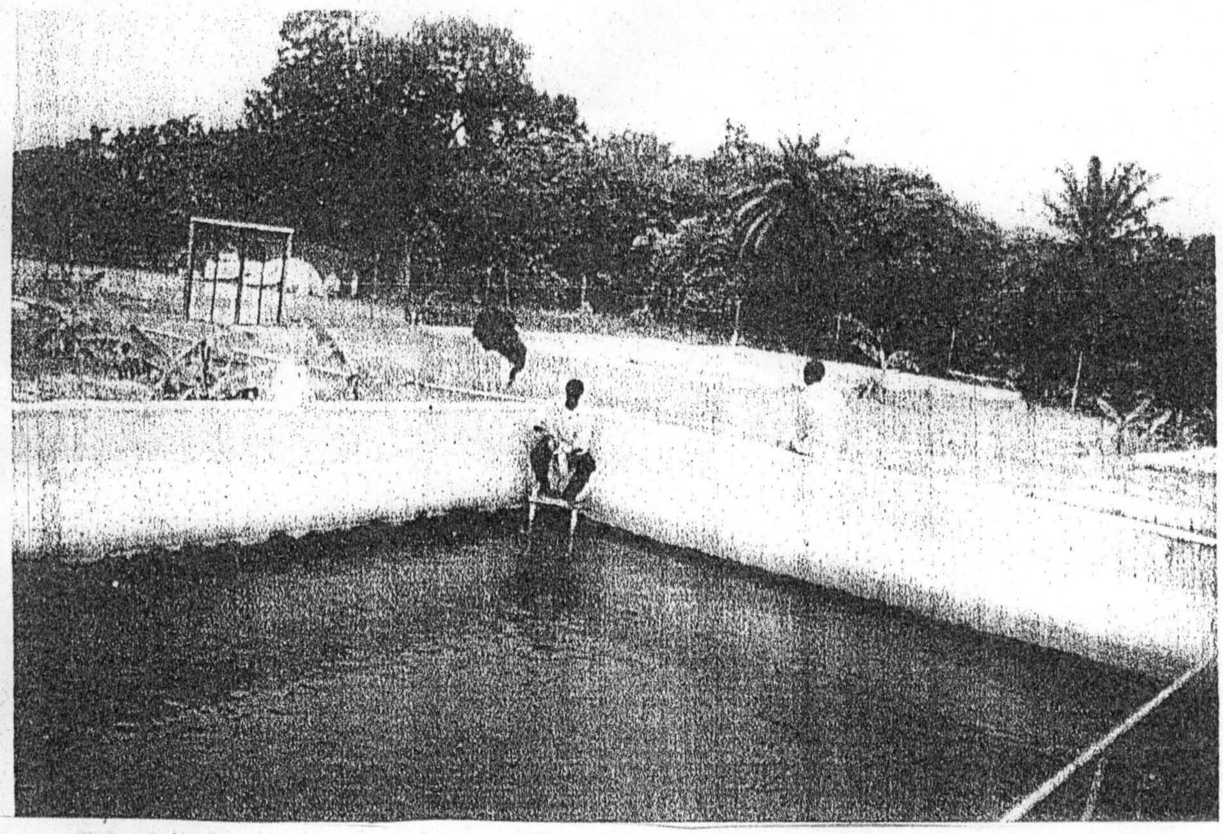


PLATE 1: Sample at the Fishpond

PLATE 2: Sample at the Weir

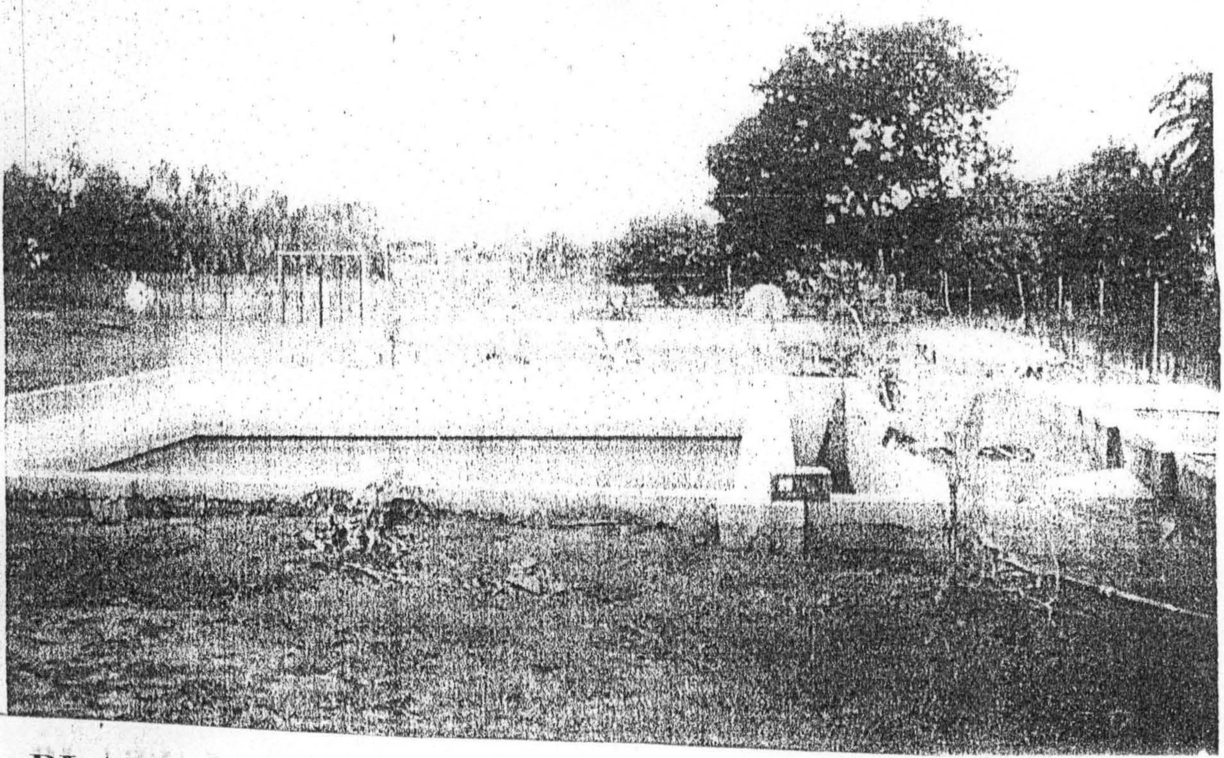


PLATE 3: Aerial View of the Fishpond

PLATE 4: Sample at the Discharge Column

3.3. Procedure for Laboratory Analysis

3.3.1. Materials, Reagents and Equipment

Different materials and reagents were used for the bacteriological and physio-chemical analysis of the samples. The materials, reagent and equipment are:

1. Test tubes
2. 10ml seriological pipette,1ml/seriological pipette.
3. Lactose broth,
4. Incubator
5. Eosin Methylene Blue(EMB)
6. Macconkey agar
7. Durham tubes
8. Autoclave
9. Oven
10. Petri dishes
11. Bunsen burner
12. Gram's stain reagent
13. Wire loop
14. Slides
15. Staining rock
16. Colony counter
17. Microscope
18. Phenol red indicator
19. Atomic Absorption Spectrometer

3.3.2. Bacteriological Qualitative Analysis Procedure

Before the presumptive test was carried out, the lactose broth was sterilized in the autoclave for 15 minutes at 121°C. All glass instrument to be used were sterilized in the oven for 1 hour at 169°C.

3.3.2.1 The Presumptive Test

Three separate series consisting of three groups making a total of nine tubes per series were arranged in a test tube rack. The tubes were labeled according to the sample source and volume of sample inoculated. The samples were thoroughly shaken, and using a 10ml pipette,100ml aliquots was inoculated into three tubes labeled LB2 X-10ml.Using a 1ml pipette,1ml of water sample was inoculated into three tubes labeled LB1 X-ml,with subsequent flaming of containers. Using a 0.1ml pipette,0.1ml of water sample was inoculated into three tubes labeled LB1X0.1ml.The procedure was repeated for the other four samples analysed.The tubes were incubated for 48 hours at 37°C.

3.3.2.2. The Confirmed Test

Before the confirmed test commenced, the prepared EMB and Macconkey media were sterilized in the autoclave for 15 minutes at 121°C. After sterilization, the EMB plates and the Macconkey agar plates were labeled. Using a positive 24 hours lactose broth culture from the presumptive test, one EMB plate and one Macconkey agar plate were streaked to obtain discrete colonies. The above mentioned procedure was repeated for the remaining samples. All plates were then incubated at an inverted position for 24 hours at 37°C.

3.3.2.3 The Completed Test

The tubes were labeled as before. One lactose broth and one nutrient agar from isolated colonies obtained from an EMB and Macconkey agar plates from the confirmed test were treated with the Graham's reagent. The procedure was repeated for all the remaining samples. Then all tubes were incubated for 24 hours at 37°C.

3.3.2.4 Total Plate Count Determination

After serial dilution of each of the water sample,1 ml of the sample were each pipetted with a sterile pipette into sterile Petri-dishes. A sterile nutrient agar in molten form was poured into the Petri-dishes and mixed properly. Incubation was done at 37°C for 48 hours. Colonies that were developed were enumerated using the colony counter. The result obtained was tabulated.

3.3.2.5 Salmonella/Shigella Tests

1 ml each of water sample was incubated into the sterilized salmonella/shigella media. It was then incubated for 48 hours at 37°C.

3.4 Physio-Chemical Qualitative Analysis Procedures

These procedures that were used to determine the physical and chemicals parameters of the samples. The major procedure is the AAS method which is used to determine a whole lot of parameters.

3.4.1 The Atomic Absorption Spectrophotometer

This is an electronic devise that is used to determine the concentrations of many parameters in a water sample. The spectrophotometer is connected to a power source. It then programs itself and requests for an input data. This data which is numeric interprets the parameters to be analyzed to the device. Over 50 parameters input data are provided with the device. After a parameter data input, the device now requests for a sample. There is a hole on the device into which a small volume of sample is poured. After pouring the sample into the hole, the device now programs itself and starts analysis. The time for this varies with different parameters, for example, the nitrate analysis takes 15 minutes. After the time has elapsed, the concentration of each parameter appears on the screen of the device. The spectrophotometer was used to determine concentrations of the following parameters in the water sample: K^+,Fe^{2+},Na^+,Ca^{2+},Mg^{2+} electrical conductivity ,hardness.

3.4.2. Biological Oxygen Demand (BOD) Test

Each grey water samples was diluted with aerated water and divided into portions. The dissolved oxygen is determined in one portion immediately and in the other after it was incubated for five days at a temperature of 20°C. The difference gave the amount of oxygen taken up by the grey water sample.

3.4.3. Chemical Oxygen Demand (COD) Test

In this test, potassium dichromate which is used as an oxidizing agent was reacted with each grey water sample. The dissolved oxygen count of the water sample was determined first before oxidation of sample with the $K_2Cr_2O_7$.After oxidation process was completed, the dissolved oxygen content of oxidized water sample was determined. The difference gave the chemical oxygen demand for each sample.

3.4.4. Dissolved Oxygen Test

The dissolved oxygen content of each water sample was measured using the dissolved oxygen test kit.

3.4.5. pH

The ph value of each sample was measured using the ph meter. The ph meter was first calibrated, and then its electrode and surrounding area was rinsed with distilled water using the squeeze bottle, and dried with a soft tissue. A clean dry 100 ml beaker was filled to the 50 ml line with the water sample to be treated. The electrode was immersed in the water. The sample was stirred once and then the displayed value was allowed to stabilize. The value was read and recorded as the ph value of the sample.

The procedure was repeated for the four remaining water samples.

However, based on the values obtained from the Pv_4 and Do or BOD analysis, it can be seen that biological treatment is the most feasible. Once the BOD, Do and odour are removed, water course can do the remaining treatment without causing harmful environmental effect.

3.5 Design Of Sedimentation Tank

The following are the parameters to be considered in designing for a sedimentation tank:

Area, shape, depth and piping

Sedimentation tank is necessary to treat the effluents like total dissolved solids, bacteriological composition because from the result of the analysis it could be seen that there is quite high faecal contamination some of which can be removed through sedimentation since they possess settling velocity.

3.5.1. Sedimentation Tank

1. The shape to use must be circular; this is because if any other shapes like rectangular, square e.t.c are used, sludge pockets occur at their corners which circular shape will definitely eliminate.

2. Using a surface diameter = 5.5m

Therefore the surface area of the tank = $\pi D^2/4 = (\pi \times 5.5^2)/4$

$$= 23.76m^2$$

the surface area of the sedimentation tank = $23.76m^2$

Depth

3. The depth of the sedimentation tank = 2.4 m. It should be laid with concrete of high grade this should be done to prevent much seepage and groundwater pollution. The side slope of 2:1 is suggested since the soil in the project site is clayey-loam, which makes it to be stable.

3.6 Labour Requirements

1. The primary labour requirement is an Engineer experienced with diffused air aerated lagoon.

2. A fairly large and reliable work force of 5-20 people is needed; one or more workers should have some experience with concrete mixer.

3. Motorized excavating equipment such as backhoe is needed because of the size of excavation.

Materials needed are:

1. Diffused air aerators (locally made from compressors) and all necessary wiring and spare parts.

2. Flat stones on mortars for lining the lagoon

3. Sewer pipe, 100 ml diameter and valves of 100 ml for inlet and outlet pipes and inter pond piping.

4. Grass seed or sod for the top and outside embankment.

5. Electric cables

6. Mortar mix.

Tools needed are:

1. Backhoe
2. Shovels

3. Electricians' tools

4. Mixing containers

5. Trowels

3.6.1 Design For 95% BOD Removal for Retention Period of 4 Days

Volume

1. The volume of each fishpond is:

Length = 10.3m

Breadth = 7.6m

Height = 4.7m

Therefore the volume = 10.3 x 7.6 x 4.7

= $367.92m^3$

3.6.2 Calculating Lagoon Size

The size of the lagoon is based on the daily flow of effluent; the BOD of the effluent which was analyzed in the laboratory; the desired BOD percentage of 95% removal; the tropical climate of the area and finally on the type and size of the aerators.

In general the capacity of the lagoon should be at least 4 times greater than the flow of effluent.

The discharge flow of effluent when the tap is opened every 14 days is 100,000 litres

Therefore minimum capacity of the lagoon = 4 x 100,000

= 400,000litres.

The minimum area of the aerated lagoon surface

Since 1000 litres =$1m^3$

400,000(litres)/1000(litres) = $400m^3$

Assuming a depth of 2.5 m

$400m^3/2.5m = 160m^2$

Proposed width = 10m

Proposed length = 160m/10m = 16m

3.6.3 Selecting A Diffused Unit Aerator

Materials needed are:

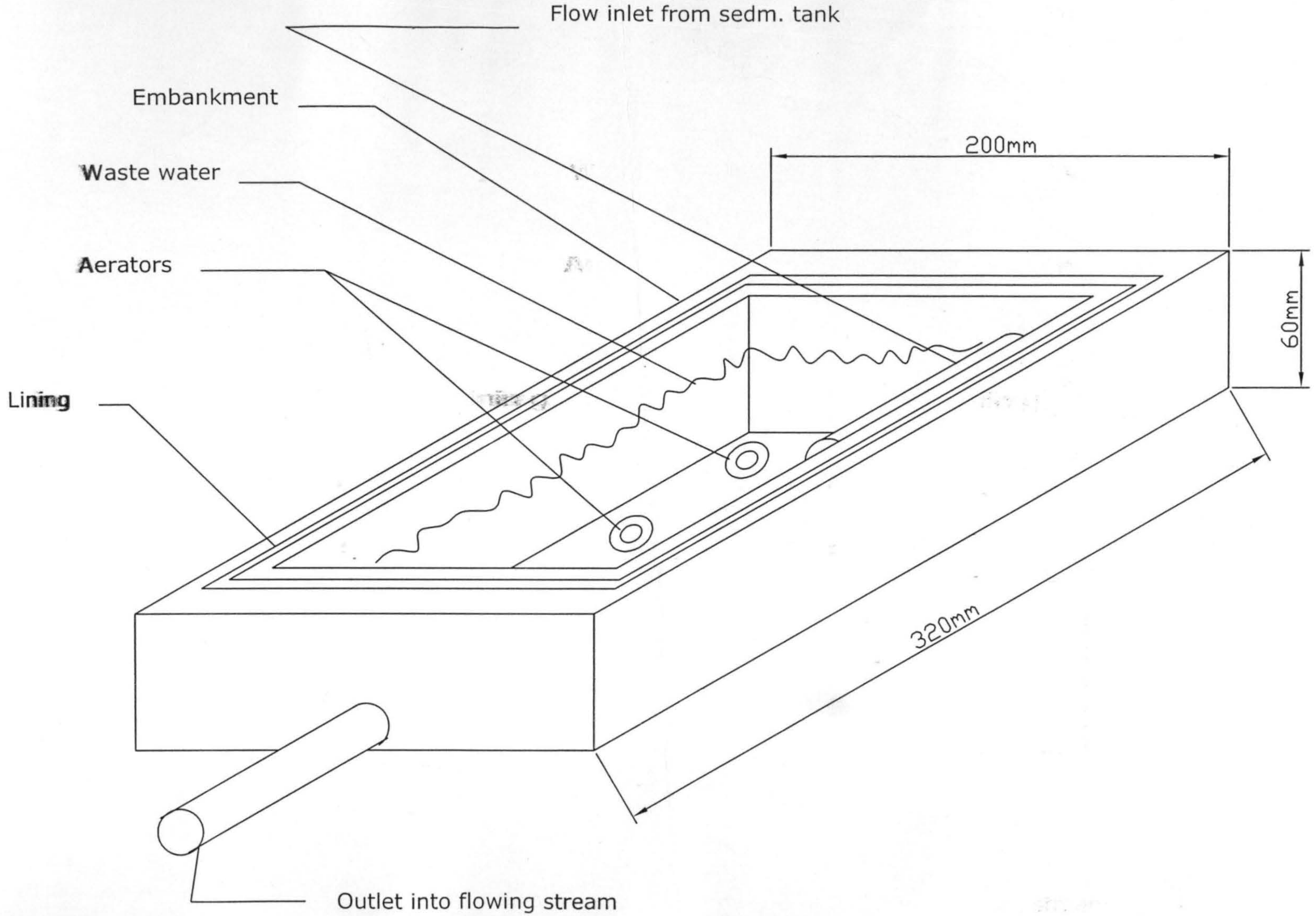
1. 3 horsepower compressor
2. 50mm diameter pipe of length 30 m
3. Perforated ceramic plate

The aerated lagoon is a dilute, well mixed, biological treatment operating without solids recycle and having detention times in the order of 1-10 days depending upon loading and desired effluent quality. Mixing is sufficient to distribute oxygen throughout the unit but may not be sufficient to keep all of the suspended solids in suspension. The diffused unit aerator is designed to deliver the required quantity of oxygen and to provide a minimum of solids deposition in the unit.

The values of hp/1000 gals are only meaningful for a specific aeration unit since the pumpage of liquids from various designs of surface aerators vary by factors of 2-10.The major factor that keeps solids in suspension is the pumpage that an aerator produces per 1000 litres of basin volume since it's the pumpage that distributes the oxygen and keeps the solids in suspension. The transfer of oxygen is related to the quantity of fluid passing through the perforated ceramic plate.

In this aerated lagoon with lagoon 4 days retention time, the 3hp chosen for aeration is a function of the oxygen demand and the 4 days detention time. The 3hp for mixing was picked as a result of the aerated lagoon volume and this horsepower varies directly with detention time.

The following figures show the sketch of the sedimentation tank, fish pond, aerator unit and aerated lagoon.



Scale 1:50

Fig. 1 **SKETCH OF AERATED LAGOON**

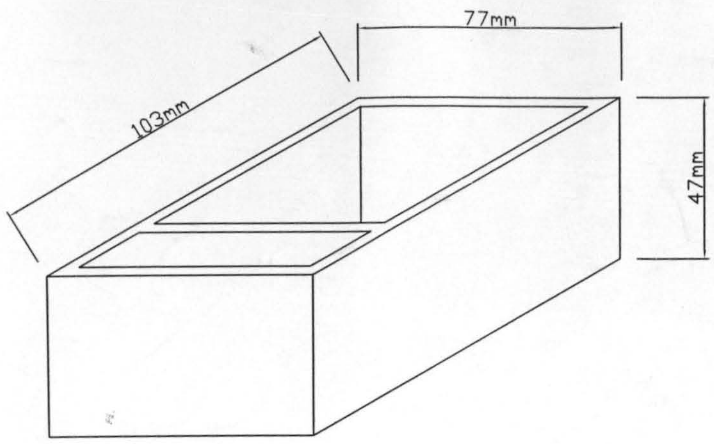


Fig. 2 Sketch of Fishpond
Scale 1:100

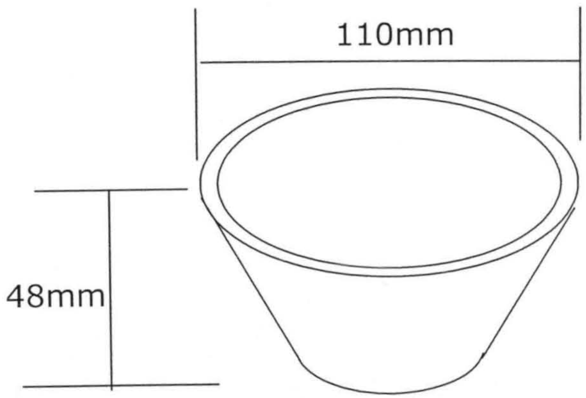


Fig. 3 Sketch of Sedimentation Tank

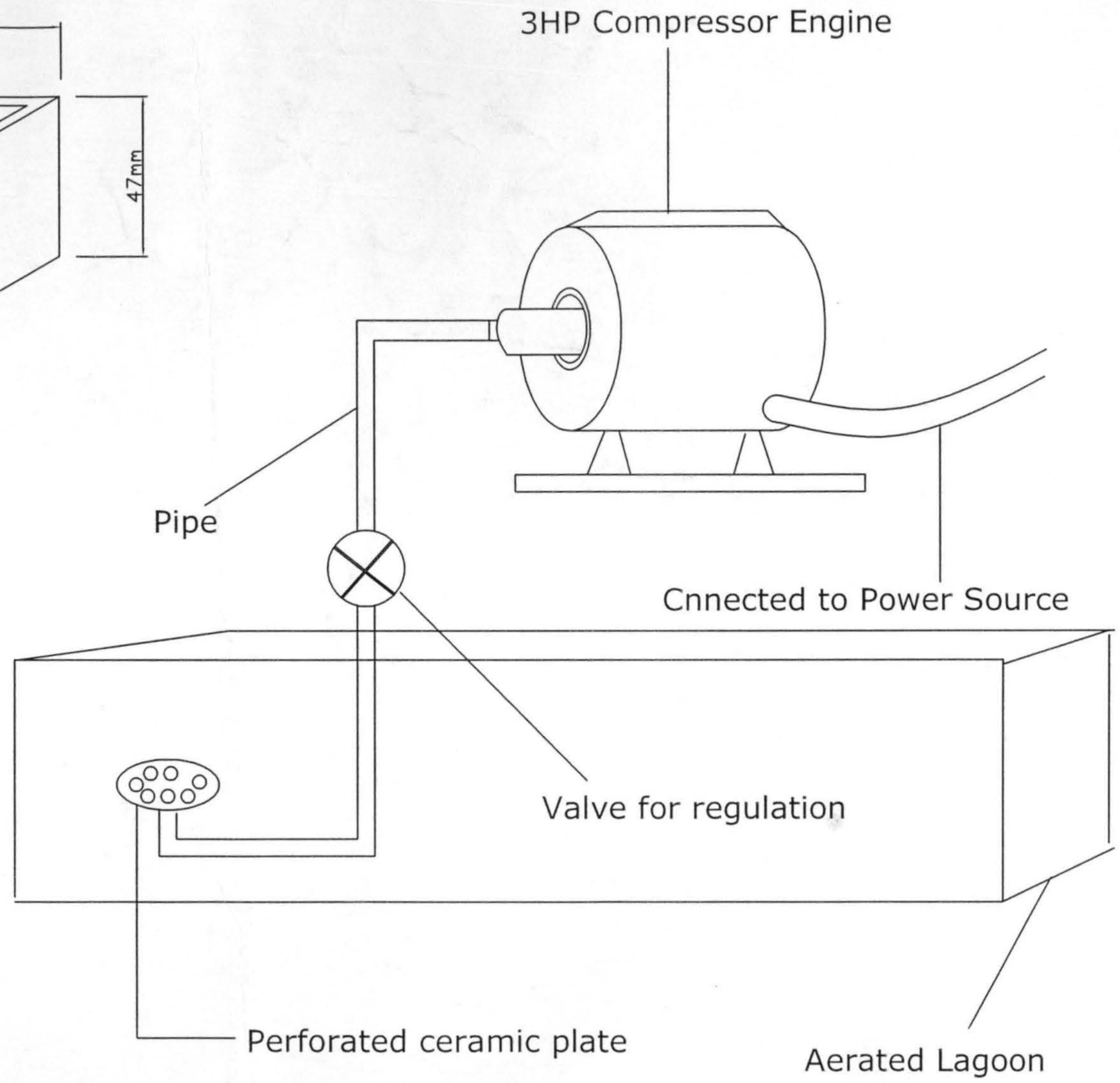


Fig. 4 Sketch of an Aerator Unit

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS OF PHYSICAL ANALYSIS OF WASTEWATER

Table 1: Physical analysis of wastewater

	A(weir)	B(fp 1)	C(fp 2)	D(dis 1)	E(dis f)
Odour	Not objectionable	Highly objectionable	Highly objectionable	Not objectionable	Not objectionable
Colour(HU)	20	28	29	23	21
Temperature(^{0}C)	27.8	32.1	30.2	28.0	28.5
TDS(mg/l)	34	156	130	110	47

Other physical characteristics are turbidity, taste, dour.

From the above table 1, it is observed that the concentrations of most of the measured parameters increased from point of entry to the fp 1 and from there the concentration decreased at the point where it was discharged to the stream.

The water has a mild odour at the weir, but it becomes objectionable as it gets to the pond but decreases at the point of discharge.

The water has deep green colour at the dis 1 and dis f but it's a bit green at both fishponds and colourless at the weir, is changes in colour is suspected to be a result of activities carried out on the pond and materials in solution.

Temperature of the wastewater ranges from 27.8 0c to 28.5 0c which according to WHO standard (1995) is within tolerable limit if it doesn't exceed 29 0c.

Turbidity of the water is very high at the fp 1, fp 2, dis 1, but its better at the weir and the dis f due to high dissolved solid.

Other physical characteristic is the total dissolved solids which rises rapidly from 34 mg/l to 156 mg/l and then drops gradually; this is accounted for by the feeding rate of the fish and other remnants of feeds left in the water. It can also be seen that it has a smaller value at the weir and the discharge f, this is probably because there is no feeding activity taking place there.

4.2 Result of Chemical Characteristics of the Wastewater

Table 2: Chemical Analysis of Wastewater.

	A(weir)	B(fp 1)	C(fp 2)	D(dis 1)	E(dis f)
Ph	6.7	7.1	6.9	7.0	7.4
Totalhardness(mgCaco$_3$)/l	13.2	8.7	9.3	11	9.8
Calcium, Ca(mg/l)	5.2	5.5	5.3	8.0	6.3
Sulphate,So$_4$	23	31	27	26	25
Chloride,Cl^-(mg/l)	2.48	2.54	2.55	2.81	2.56
Iron,Fe^{2+} (mg/l)	0.11	0.00	0.00	0.30	0.12
Magnessium,Mg^{2+}(mg/l)	0.2	7.8	3.6	4.1	2.5
Phosphate,Po^-_4(mg/l)	2.3	6.7	5.61	4.0	3.6
Nitrate,No^-_3(mg/l)	6.9	13.0	14.2	13.9	16.4
Sodium,Na^+(mg/l)	0.12	2.8	6.0	5.3	3.9
Potassium$^+$(mg/l)	1.3	1.8	2.6	2.81	1.9
Copper,Cu^+(mg/l)	1.70	0.25	0.20	0.21	1.31

Manganese, Mn^{+}(mg/l)	1.20	0.10	0.05	0.04	0.90
Chlorine,(mg/l)	0.10	0.80	3.10	2.71	0.60
Boron, Br^{+}(mg/l)	0.00	0.04	0.00	0.00	0.00
COD,(mg/l)	0.97	4.50	9.00	10.60	9.60

From the laboratory analysis carried out, the table 2 represents the results.

It was observed that the wastewater is rich in potassium, sodium, nitrate, which are essential macro elements for crop growth and therefore can be used for irrigation purposes but the presence of higher concentrations of magnesium, copper, iron, boron, calcium, and chlorine ions will lead to salinity of the soil if used directly, therefore it cannot be used for irrigation without proper treatment or dilution.

Also nitrate and phosphate concentrations in the wastewater is suspected to have nitrates and phosphates being leached from the adjacent soil as a result of yearly application of NPK fertilizer on the surrounding farmland.

The observed improvement in quality, also known as self purification from the dis 1 to dis f has been attributed to oxidation of organic and nitrogenous materials, settling of heavy solids and coagulation of lighter ones.

4.3. Result of Biological Characteristics of the Wastewater

Table 3: Biological analysis of wastewater

	A(weir)	B(fp1)	C(fp 2)	D(dis 1)	D(dis f)
DO(mg/l)	2.5	1.8	1.99	0.96	0.91
Faecal coli form(cfu/ml)	0	127	189	120	10
Faecal streptococci(cfu/ml)	0	108	156	137	15

E.coli(cfu/ml)	2	56	23	45	45
Total plate count(cfu/ml)	2	76	45	170	23
Pv_4 (mg/l)	2.7	7.4	6.2	32	29.3
BOD (mg/l)	19.2	36.7	37	220	120

The above table 3 gives the results of biological analysis of the wastewater.

There is high concentration of oxygen but this drops sharply as a result of increased fish activities and organic activities taking place in the pond.Also lack of faecal coliform group parameters indicate the absence of human and livestock faeces but this changes as the water enters the pond and the discharged faeces of fish might have increased the concentration in the water.

Research carried out by Sangodoyin and Tanumo (1995) revealed that for biological treatment to be applicable, the BOD to PV_4 value should be high. Since the value of BOD:PV_4 according to table 3 is higher, therefore it should be treated biologically.

4.4 Relevance of Aerobic Lagoon

1. The land area is big.

2. It is not for domestic but for discharge without creating nuisance.

3. It is for proper monitoring and dilution of toxic ions for the treated water to be useful for irrigation purposes.

4. Since during dry seasons water is scarce in the area, the use of aerated lagoon with a detention period of few days can make recyclelatory system feasible.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The wastewater samples taken from the fishpond were analyzed and studied properly to determine their physical, chemical and biological parameters. Also based on the result of the analysis it was discovered that the water need to be treated before it can be used for domestic purposes like washing, cooking e.t.c and agricultural purposes like irrigation.

From the biological analysis comparison of BOD: PV4 compounds which was on the high side therefore biological treatment method was chosen. The farm has a large and available land of (10m x 16m) size was designed for the aerated lagoon on the farm after the water has been temporarily treated in the sedimentation tank. The dissolved solids, odour, colour and toxic ions would then be diluted with water and discharged directly to the water course since the dissolved oxygen and BOD would have conformed to the 20/30 standard by APHA (1995).

5.2 Recommendations

I recommend that further researches should be done to ascertain the extent of groundwater pollution by the fishpond wastewaters.

The sedimentation tank and aerated lagoon should be constructed and performance evaluation done to ascertain the feasibility of the designed lagoon.

There should also be proper maintenance like sludge removal, proper aeration should be done to prolong the lifespan of both sedimentation tank and the aerated lagoon.

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