EVALUATION OF BENUE BREWERY WASTEWATER.

BY

LAN BEM JOSEPH

2003/15027EH

CHEMICAL ENGINEEEERING DEPARTMENT

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE, NIGERIA.

NOVEMBER, 2008.

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A THESIS SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING AS A PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE AWARD OF BACHELOR OF ENGINEERING (B.ENG). DEGREE IN THE

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NOVEMBER, 2008.

DECLARATION

I hereby declare that this thesis is wholly and solely written by me under the supervision of Engr. M.S. Galadima. Information hereby obtained from published and unpublished work of others have been duly referenced and acknowledged.

.... 3-12-08 ....

LAN BEM JOSEPH **DATE**

2003/15027EH

CERTIFICATION

I hereby testify that this work has been supervised, read and has met part of the requirement for the award of bachelor of Engineering (B.Eng.) Degree in the Department of Chemical Engineering, Federal University of Technology, Minna Niger State, Nigeria.

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DEDICATION

This project work is dedicated to the almighty God by whose grace I am able to see this day.

ABSTRACT

Evaluation of Benue brewery wastewater was carried out in this work. Parameters such as pH, Chemical oxygen Demand (COD) titratable alkalinity, total suspended solid, chloride, total hardness were evaluated before and after the treatment of the wastewater. Analysis showed that the pH, COD, Titratable alkalinity, total suspended solid, chloride and total hardness of the wastewater before treatment were 4.67, 1617, 190,174,437.36, 595 respectively.

More so, analysis showed that the pH, COD, Titratable alkalinity, total suspended solid, chloride and total hardness after treatment were 5.80, 78, 80, 0.0, 90, 150.

Therefore, the percentage reduction of the parameters of the waste water before and after treatment showed of pH to be -24.197%, that of chemical oxygen demand to be 95.176%, Tatratable alkalinity 57.89%, Total suspended solid 100%, Chloride 75.42%, Total hardness 74.81%.

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CHAPTER ONE

1.0 INTRODUCTION.

Evaluation of brewery liquid effluents can be said to be the act of considering or examining the value, quality, extent or condition of effluents discharged into the environment. It helps in the identification, prediction, interpretation and communication of information about the impact of an action on human xhealth and his or her wellbeing also including the wellbeing of ecosystem in hwhich survival depends.

This action which contains an analysis of the likely effects, good and bad on the eviroment is mainly caused by the activities of te chemical processing industries in any location or set up.

In carrying out production activities of chemical industries, the yield the product, by products and effluents. In most cases the by products and effluents constitute certain harzadous effluents when discharged to the surrounding causing environmental degradation destruction. Almost all chemical processing industries discharge toxic and non tixic ewate and are therefore all quality of environmental dregradation and destruction which needs to be accesed for the survival of human race and its ecosystem.

Therefore the waste (effluents) coming out of chemical process has to be properly treated before discharging them into the environment if llife is to be adequautely protected. The following are the waste discharge from the benue brewery.

1. Gasous effluents
2. Solid waste
3. Liquid waste
4. Operational noise

Gaseous waste; that is been generated by the brewery is mainly from the burning of fossil fuel for the generation of energy. This contaminants the atmosphere. These gaseous wastes from brewery industry consist of five principal classes of air pollutants; these are carbon monoxide, particulate matter, sulphur oxide, gaseous hydrocarbon and nitrogen oxide.

Liquid waste; forms most of the effluents generated in the brewery. This waste is generated mainly by the three departments; packaging, production and engineering and the nature of the effluents ranges between acidic and alkaline medium. The highest percentage of effluents is produced during the cleaning of sterilization of vessels of the connecting pipe. During daily scrubbing of floors by the use of chemicals, a lot of effluents is generated within the industry.

Solids; solid waste from the brewery industry are mainly spent grains which are obtained during filtration, process. Other important solid effluents from the brewery are broken bottles and crates. Most of the solid effluents or waste of brewery industry can be used for several purposes. Spent grain used as poetry field. The broken bottle is remoulded and used for producing bottle and other types of glass materials

1.1 Benue Brewery Limited

is situated at 5 KM away from Makurdi along Gboko road on an elegant piece of land measuring 15 Hectares at the bank of Benue River. The Company was incorporated in March 1978, with Limited liability, however the Plant could be commissioned much later in July 1982 The Brewery has a capacity to produce annually150000 HL of beer i.e. two million crates of beer

1.2 Components of Beer

According to the German Purity Law, the natural components of beer are:

- water,
- malt
- hops
- brewer's yeast.

1.3 Phases of Beer Production

Milling

The malt, produced from special brewer's barley, has to be grinded in a malt-mill (two or four roller mill).

Mashing

In the mash- and wortkettle the grinded malt is mixed with water. The unsoluted starch is transformed into malt-sugar by natural enzymes contained in the malt and is soluted. This „sweet" solution is called wort. .

Lautering.

The solid parts of the malt, the so-called spent grains, are separated in the lauter tun. This filtration process is called lautering. The clear wort and the spargings (washing of the spent grains cake) are pumped into the wort kettle.

The spent grains are valuable fodder, which can be sold to local farmers.

Wort Boiling.

The lautered wort is boiled with hops for about 90 minutes. . The sweetness of the malt sugar and the bitterness of the hop, blended in an adequate proportion, give the beer its big taste.

The removing of the hot break in the whirlpool.

The protein particles, which coagulate during wort boiling, are separated in the whirlpool.

Wort-cooling.

The finished wort is cooled down with a plate-cooler from boiling temperature to about 6°C within more or less an hour.

Fermentation.

In the fermentation cellar, brewer's yeast is added to the cooled wort, causing the malt sugar to transform into alcohol and carbon dioxide. This fermentation process takes approximately one week, at temperatures ranging from 6°C to 10°C. The almost completely fermented wort is calle d green beer. The green beer is now pumped into the storage cellar.

Storage and Maturation.

In the storage tanks, the green beer is stored at temperatures between 0°C and 3°C for about 3 weeks. In this phase, the rest of the malt sugar is fermented, and the beer will mature. The carbon dioxide dissolves in the beer. The natural turbid beer is now ready for consumption. The beer can either be dispensed or it is, as customary in large breweries, filtrated and then filled into casks or bottles.

Filtration.

The yeasts and turbid components, such as, for example, proteins, are taken out of the beer by means of filtration. The beer gets its typical appearance and is stored in a pressure tank until it is racked.

Racking.

Finally, the beer is filled into casks or bottles.

1.4 Aim and Objectives.

This project is aimed at evaluating the liquid effluent from the benue brewery to help improve the living standard of the community through proper treatment of the effluent from the industry.

Its objective is to estimate the likely consequences of the discharged effluent of Benue brewery limited plc. Plant on the receiving body (River Benue) which is mainly known for agriculture, fishing and farming purposes.

To study the active compliance of Benue Brewery limited plc. Management with the environmental set standard for brewery industry in Nigeria.

1.5 Justification of the Study

The study, evaluation of waste water extends its grip to many process industries such as agricultural (agro based), mining, brewing.

The study is done mainly for the purpose of solving economic, soc ial and environmental problems affecting Benue river and its environs.

1.6 Project Scope

This research project work limits itself at analyzing the liquid effluents being discharged into Benue River and to check for the effect of these releases if any.

CHAPTER TWO

2.0 LITERATURE REVIEW

The brewing process generates a unique, high-strength wastewater as a by-product. The wastewater typically has a high concentration of biochemical oxygen demand (BOD) from the carbohydrates and protein used in brewing beer. Brewery wastewater usually has a warm temperature (greater than 100°F). The high level of soluble BOD and the warm temperature make brewery wastewater an ideal substrate for anaerobic treatment. Anaerobic treatment of brewery wastewater is a proven process. More than 250 full-scale systems are operational worldwide. Anaerobic wastewater treatment systems generate an alternative fuel source known as biogas. Biogas is similar to natural gas but has a lower BTU value, contains more moisture, and often has contaminants such as H(2)S. Biogas is a unique substance that must be handled with safety. Specific guidelines and standards should be followed for the safe handling of biogas. In this presentation, types of biogas handling equipment, materials of construction, and application highlights will be discussed. There are many applications for utilizing biogas instead of disposing of it with a flare. One of the most common applications of biogas use is as a fuel in boilers. Since anaerobic digestion systems require a heat source, biogas can be a free fuel. Biogas can also be blended with natural gas for use in production plant boilers. Heating equipment variations will be presented and discussed. Biogas can also be used to generate electricity. With energy costs at an all-time high, alternative fuel sources, especially "green power", are in demand. Equipment such as internal combustion engines, microturbines, Stirling Cycle engines, fuel cells, and absorption chillers are specifically designed to transform biogas into power. The pros and cons of this equipment will be presented. Biogas handling and utilization equipment can be expensive. The interest in the utilization of biogas is evident by the increasing sources of funding available for private and public projects of this nature. Major sources of funding will be listed for interested parties. With funding assistance and proper equipment selection and engineering, biogas utilization can be a cost-effective means of developing green energy.

High-quality water is one of the main ingredients in beer, and a priority for our breweries and the communities where we operate. It is also an important consideration in our agricultural and entertainment businesses.

2.1 Wastewater Management

Brewery wastewater has a high organic composition. Because of this and the potential impact it can have on a community's wastewater treatment system, Anheuser-Busch relies on two innovative processes for managing wastewater:

- Bio-Energy Recovery Systems (BERS), an anaerobic wastewater management system that reduces organic load and captures energy from wastewater; and
- Land application, where wastewater byproducts from the brewing process are applied to the land, returning water and nutrients to the soil.

2.2 Bio-Energy Recovery Systems

- Anheuser-Busch uses Bio-Energy Recovery Systems (BERS) to manage brewery wastewater at a majority of our breweries. Through BERS, brewing-related wastewater is processed anaerobically (in the absence of oxygen) and the resulting biogas (methane) is captured; wastewater is then discharged to the local sewer system (see the energy section for more information). Managing wastewater in this fashion reduces its strength by up to 90 percent, decreasing its impact on local wastewater treatment systems. In addition, the excess biosolids generated by BERS are typically reused to start up or "seed" other systems.

2.3 Industry Description and Practices

Beer is a fermented beverage with low alcohol content made from various types of grain. Barley predominates, but wheat, maize, and other grains can be used. The production steps include:

• *Wort production:* grinding the malt to grist; mixing grist with water to produce a mash in the mash tun; heating of the mash to activate enzymes; separation of grist residues in the lauter tun to leave a liquid wort; boiling of the wort with hops; separation of the wort from the trub/hot break (precipitated residues), with the liquid part of the trub being returned to the lauter tub and the spent hops going to a collection vessel; and cooling of the wort.

• *Beer production:* addition of yeast to cooled wort; fermentation; separation of spent yeast by filtration, centrifugation or settling; bottling or kegging. Water consumption for breweries generally ranges 4–8 cubic meter per cubic meter (m3/m3) of beer produced. Water consumption for individual process stages, as reported for the German brewing industry.

2.4 Waste Characteristics

Breweries can achieve an effluent discharge of 3–5 m3/m3 of sold beer (exclusive of cooling waters). Untreated effluents typically contain sus-pended solids in the range 10–60 milligrams per liter (mg/l), biochemical oxygen demand (BOD) in the range 1,000–1,500 mg/l, chemical oxygen demand (COD) in the range 1,800–3,000 mg/l, and nitrogen in the range 30–100 mg/l. Phosphorus can also be present at concentrations of the order of 10–30 mg/l. Effluents from individual process steps are variable. For example, bottle washing produces a large volume of effluent that, however, contains only a minor part of the total organics discharged from the brewery. Effluents from fermentation and filtering are high in organics and BOD but low in volume, accounting for about 3% of total wastewater volume but 97% of BOD. Effluent pH averages about 7 for the combined effluent but can fluctuate from 3 to 12 depending on the use of acid and alkaline cleaning agents. Effluent temperatures average about 30°C. Solid wastes for disposal include grit, weed seed, and grain of less than 2.2 millimeters in diameter, removed when grain is cleaned; spent grain and yeast; spent hops; broken bottles or bottles that cannot be recycled to the process; and cardboard and other solid wastes associated with the process, such as kieselguhr (diatomaceous earth used for clarifying). Breweries do not discharge air pollutants, other than some odors.

2.5 Treatment Technologies

If the brewery does not discharge to a municipal sewer, primary and secondary treatment of the effluent is required. Primary treatment facilities may include pH adjustment, roughing screens, grit-settling chambers, and a clarifier. Choices of processes for removing BOD in a secondary treatment stage include anaerobic treatment followed by aerobic treatment and activated sludge systems. Sludges from the clarifier are dewatered and disposed of through incineration or to an approved landfill. Where the brewery is permitted to discharge to a municipal sewer, pretreatment may be required to meet municipal by-laws and to lessen

the load on the municipal treatment plant. In some cases, sewer discharge fees imposed by the municipality on effluent volume and on the suspended and BOD loads may encourage the brewery to install its own treatment facility. Modern plants using good industrial practices are able to achieve the following performance in terms of pollutant loads. Water conservation and recycling will allow water consumption to be kept to a minimum. A new brewery should target on achieving an effluent range of 3–5 m3/m3 beer produced. Provision for recycling liquors and reusing wash waters will help reduce the total volume of liquid effluent. A new brewery should set as a target the achievement of a treated effluent that has less than 0.3 kilograms (kg) of BOD/m3 beer produced and 0.3 kg of suspended solids/m3 beer produced (assuming discharge to receiving waters). Odor emissions can be minimized if exhaust vapors are condensed before they are released to the atmosphere or if vapors are sent to the boiler and burned.

2.6 Industry Sector Guidelines

The guidelines given below present emissions levels normally acceptable to the World Bank Group in making decisions regarding provision of World Bank Group assistance. Any deviations from these levels must be described in the World Bank Group project documentation. The emissions levels given here can be consistently achieved by well-designed, well operated, and well-maintained pollution control systems.

The guidelines are expressed as concentrations to facilitate monitoring. Dilution of air emissions or effluents to achieve these guidelines is unacceptable. All of the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. *Liquid Effluents* The effluent levels presented in Table 2 should be achieved. *Ambient Noise* Noise abatement measures should achieve either the levels given below or a maximum increase in background levels of 3 decibels (measured on the A scale) [dB(A)]. Measurements are to be taken at noise receptors located outside the project property boundary.

Table 1. Effluents from Breweries (milligrams per liter, except for pH and temperature)

Parameter Maximum value

Ph	6-9
BOD	50
COD	250u
TSS	50
Oil and grease	10
Ammonia nitrogen (NH_4-N)	10
Phosphorus	5

Note: Effluent requirements are for direct discharge to surface waters.

The effluent should result in a temperature increase of no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge.

Maximum allowable log equivalent (hourly measurements), in dB(A)

Day Night

Receptor (07:00–22:00) (22:00–07:00)

Residential, institutional, educational 55 45 Industrial, commercial 70

2.7 Monitoring and Reporting

Monitoring of the final effluent for the parameters listed in this document should be carried out at least once per month or more frequently if the flows vary significantly. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary Corrective actions can be taken. Records of monitoring results should be kept in an acceptable format. The results should be reported to the responsible authorities and relevant parties, as required.

Key Issues

The key production and control practices that will lead to compliance with emissions requirements can be summarized as follows:

1. Implement sound maintenance and housekeeping procedures.
2. Minimize water consumption and effluent generation through recycling and reuse of process streams.
3. Dispose of process solid wastes as by-products for animal feed.
4. Send broken and rejected bottles and waste cardboard to recycling plants.
5. Maintain effluent treatment facilities to operating design specifications.

2.8 Overview of Pollution

Pollution is the introduction of contaminants into an environment, of whatever predetermined or agreed upon proportions or frame of reference; these contaminants cause instability, disorder, harm or discomfort to the physical systems or living organisms therein.[1] Pollution can take the form of chemical substances, or energy, such as noise, heat, or light energy. Pollutants, the elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed natural levels. Pollution is often classed as point source or nonpoint source pollution.

Sometimes the term pollution is extended to include any substance when it occurs at such unnaturally high concentration within a system that it endangers the stability of that system. For example, water is innocuous and essential for life, and yet at very high concentration, it could be considered a pollutant: if a person were to drink an excessive quantity of water, the physical system could be so overburdened that breakdown and even death could result. Another example is the potential of excessive noise to induce imbalance in a person's mental state, resulting in malfunction and psychosis; this has been used as a weapon in warfare

2.9 Major Forms of Pollution and Major Polluted Areas

The major forms of pollution are listed below along with the particular pollutants relevant to each of them:

2.9.1 Water Pollution

is the contamination of water bodies such as lakes, rivers, oceans, and groundwater caused by human activities, which can be harmful to organisms and plants which live in these water bodies.

Although natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water, water is typically referred to as polluted when it impaired by anthropogenic contaminants and either does not support a human use (like serving as drinking water) or undergoes a marked shift in its ability to support its constituent biotic communities. Water pollution has many causes and characteristics. The primary sources of water pollution are generally grouped into two categories based on their point of origin. Point-source pollution refers to contaminants that enter a waterway through a discrete "point source". Examples of this category include discharges from a wastewater treatment plant, outfalls from a factory, leaking underground tanks, etc. The second primary category, non-point source pollution, refers to contamination that, as its name suggests, does not originate from a single discrete source. Non-point source pollution is often a cumulative effect of small amounts of contaminants gathered from a large area. Nutrient runoff in storm water from sheet flow over an agricultural field, or metals and hydrocarbons from an area with high impervious surfaces and vehicular traffic are examples of non-point source pollution. The primary focus of legislation and efforts to curb water pollution for the past several decades was first aimed at point sources. As point sources have been effectively regulated, greater attention has come to be placed on non-point source contributions, especially in rapidly urbanizing/suburbanizing or developing areas.

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical or sensory changes. While many of the chemicals and substances that are regulated may be naturally occurring (iron, manganese, etc) the concentration is often the key in determining what is a natural component of water, and what is a contaminant. Many of the chemical substances are toxic. Pathogens can produce waterborne diseases in either human or animal hosts. Alteration of water's physical chemistry include acidity, electrical conductivity, temperature, and eutrophication. Eutrophication is the fertilisation of surface water by nutrients that were previously scarce. Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases,[1][2] and that it accounts for the deaths of more than 14,000 people daily.

2.9.2 **Air Pollution**

The release of chemicals and particulates into the atmosphere. Common air pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight.

2.9.3 Soil Contamination

Occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, MTBE herbicides, pesticides and chlorinated hydrocarbons.

2.9.4 Radioactive Contamination

Resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

2.9.5 Light Pollution

includes light trespass, over-illumination and astronomical interference.

2.9.6 Visual Pollution

which can refer to the presence of overhead power lines, motorway billboards, scarred landforms (as from strip mining), open storage of trash or municipal solid waste.

2 .9.7 Thermal Pollution

Is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.

2.9.8 Sources and Causes of Pollution

Motor vehicle emissions are one of the leading causes of air pollution. China, United States, Russia, Mexico, and Japan are the world leaders in air pollution emissions; however, Canada is the number two country, ranked per capita. Principal stationary pollution sources include chemical plants, coal-fired power plants, oil refineries, petrochemical plants, nuclear waste disposal activity, incinerators, large livestock farms (dairy cows, pigs, poultry, etc.), PVC factories, metals production factories, plastics factories, and other heavy industry.

Some of the more common soil contaminants are chlorinated hydrocarbons (CFH), heavy metals (such as chromium, cadmium--found in rechargeable batteries, and lead--found in lead paint, aviation fuel and still in some countries, gasoline), MTBE, zinc, arsenic and benzene. In 2001 a series of press reports culminating in a book called *Fateful Harvest* unveiled a widespread practice of recycling industrial byproducts into fertilizer, resulting in the contamination of the soil with various metals. Ordinary municipal landfills are the source of many chemical substances entering the soil environment (and often groundwater), emanating from the wide variety of refuse accepted, especially substances illegally discarded there, or from pre-1970 landfills that may have been subject to little control in the U.S. or EU. There have also been some unusual releases of polychlorinated dibenzodioxins, commonly called *dioxins* for simplicity, such as TCDD.

Pollution can also be the consequence of a natural disaster. For example, hurricanes often involve water contamination from sewage, and petrochemical spills from ruptured boats or automobiles. Larger scale and environmental damage is not uncommon when coastal oil rigs or refineries are involved. Some sources of pollution, such as nuclear power plants or oil tankers, can produce widespread and potentially hazardous releases when accidents occur.

In the case of noise pollution the dominant source class is the motor vehicle, producing about ninety percent of all unwanted noise worldwide.

2.10 Effects of Pollution

2.10.1 Human Health

Adverse air quality can kill many organisms including humans. Ozone pollution can cause respiratory disease, cardiovascular disease, throat inflammation, chest pain, and congestion. Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water by untreated sewage in developing countries. Oil spills can cause skin irritations and rashes. Noise pollution induces hearing loss, high blood pressure, stress, and sleep disturbance.

2.10.2 Ecosyste ms

- Sulfur dioxide and oxides of nitrogen can cause acid rain which reduces the pH value of soil.
- Soil can become infertile and unsuitable for plants. This will affect other organisms in the food web.
- Smog and haze can reduce the amount of sunlight received by plants to carry out photosynthesis.
- Invasive species can out compete native species and reduce biodiversity. Invasive plants can contribute debris and biomolecules (allelopathy) that can alter soil and chemical compositions of an environment, often reducing native species competitiveness.

- Biomagnification describes a situation where toxins may be pass through trophic levels, becoming exponentially more concentrated in the process

2.11 Prevention and Control of Pollution

Pollution prevention and control are best practiced through effective management, maintenance, and housekeeping in a process that incorporates water conservation and recycling, energy conservation, and disposal of solid wastes as by-products. Some options that may be considered include:

- Clean-in-place (CIP) methods for decontaminating equipment
- High-pressure, low-volume hoses for equipment cleaning
- Re circulating systems on cooling water circuits
- Use of grit, weed seed, and discarded grain as chicken feed
- Use of spent grain as animal feed, either 80% wet, or dry after evaporation
- Disposal of wet hops by adding them to the spent grain
- Disposal of spent hop liquor by mixing with spent grain
- Use for livestock feed of spent yeast that is not reused
- Disposal of trub by adding it to spent grain
- Recovery of spilled beer, adding it to spent grain that is being dried through evaporation
- Filtration of bottom sediments from final fermentation tanks for use as animal feed
- Reduction of energy consumption through reuse of wort-cooling water as the process water for the next mash
- Collection of broken glass, bottles that cannot be used, and waste cardboard for recycling.

Consideration should be given to the use of non-phosphate-containing cleaning agents. Breweries have a favorable steam-to-electricity ratio. Planning for cogeneration of electricity may be advantageous.

2.12 Emissions Guidelines

Emissions levels for the design and operation of each project must be established through the environmental assessment (EA) process on the basis of country legislation and the *Pollution*

Prevention and Abatement Handbook, as applied to local conditions. The emissions levels selected must be justified in the EA and acceptable to the World Bank Group.

CHAPTER THREE

3.0 METHODOLOGY

The sample for this project was gotten at the discharge point of the benue brewery ltd. The sample was collected and preserved in well sterilized containers by refrigeration.

The sample was finally analysed for its chemical chemical characteristics such as pH, total hardness, titratable alkalinity, total suspended solid, chloride, chemical oxygen demand,(COD).

Dosages of chemicals added to the waste water basically were alum and lime,sample of water were collected in 500ml.

For alum used determination, 70mg/l alum was dissolved into 1000cm3 and standard solution was obtained. 5ml of alum solution were added to the sample and mixed and allowed to settle, the filtered. pH of the sample was taken. The dosage is taken to calculate for the amount to be used for 2000ml of waste water collected.

5ml ⟶ 200ml

Xml ⟶ 2000ml

X=5 x 2000/200 = 50ml

For lime used determination. The amount of lime added to bring the pH to about 5.80 was 3ml.Therefore the required lime to be added to 2000ml of waste water collected.

4ml ⟶ 200ml

Xml ⟶ 2000ml

X = 4 x 2000/200 = 40ml

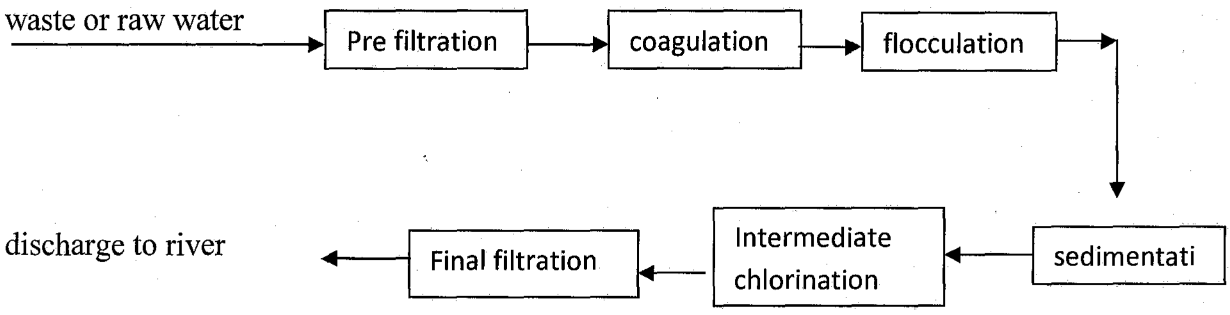

Fig. 1. Procedure for Water Treatment

For pre-filtration to occur, alum was first used in the purification process and left to stand for about 4hrs to coagulate, flocculate and sediment(sludge remover), after all of these process occured. Filtration through filter paper was done. Than intermediate chlorination which means addition of chlorine to disinfect and raduce the odor of the waste water. Since alum was used, the pH value also increased and in other reduce its pH, lime was added as pH control. After which final filtration was done using filter paper.

3.1 **pH** (determination using phenol red)

Enter the stored program number for the ph method, press PRGM display will show PRGM press 75 ENTER, the display then shows pH and the ZERO icon. Fill a sample cell with 10ml of sample (the blank). Place the blank in the cell holder tightly cover the sample cell with the instrument cap. Press ZERO, the cursor will move to the right, then the display will show; 6.0 pH. Fill another with 10ml of sample (sample temp. must be 21-23^{0c}). Using a disposable dropper, add 1ml of phenol red indicator solution in the cell (a prepared sample) cap the sample cell and invert to mix. Place the prepared sample into the cell holder. Tightly cover the sample with the instrument cap. Press READ, the cursor will move to the right and the ph value will display.

3.2 Chemical Oxygen Demand (COD)

The Chemical Oxygen Demand (COD) test is used widely to estimate the amount of the organic matter in waste water. It is the measurement of the oxygen equivalent of the material present in the wastewater that is subject to oxidation by a strong chemical oxidant, in these case dichromate. When wastewater contains only readily available organic bacterial food and no toxic matter, the COD test result provides a good estimate of Biochemical Oxygen Demand (BOD).

Sample

Homogenized 100ml of sample for 30 seconds in a blender turn on a COD reactor, pre heat to 150^{oc}, place the plastic shield in front of the reactor remove the cap of the COD digestion reagent vial for the appropriate range. Hold the vial at a 45oc angle –pipette 2ml (0.2ml) for the 0-15000 mg/l range of sample into the vial. Replace the vial cap tightly. Rinse the outside of the COD vial with deionized water and wipe the vial clean with a paper towel. Hold the vial by the cap and over a sink. Invert the gently several times to mix the content. Place the vial in the preheated COD reactor. Prepare a blank by repeating step 3-6 by substituting 2ml (0.2mole for the a 0-15000mg range.) heat the vial for 2 hours turn the reactor off wait about 20minutes for the vial to cool to 120^{oc} or less. Invert each vial several times while still warm. Place the vial into the rack. Wait until the vial into room temperature.

3.3 Titratable Alkalinity

Reagent:

0.02N sulphoric acid or hydrochloric acid: Dilute 200 moles of 0.1N standard acid to 1L with distilled water. 0.1N standard sulphoric acid or hydrochloric acid: dilute 3ml concentrated H_2SO_4 or 8.3ml concentrated HCL with 1L with distilled water.

Bromcresol green indicator solution, pH 45 indicator; dissolve 100mg bromcresol green, sodium salt in 100ml distilled water.

procedure:

Measure out 100ml of the sample into the 250ml beaker and titrate using 0.02N H_2SO_4. Put 3-4 drops of bromcresol green indicator and titrate till the color changes from green to yellow.

calculation:

$$\text{Alkalinity, mg/l as } CaCO_3 = \frac{(A\text{-}B) \times N \times 50{,}000}{\text{Ml sample}}$$

Where A= ml standard acid used for sample

B= ml standard used for blank

N the normality of used acid (0.02m)

3.4 Total Suspended Solid (Photometric Method)

Press PRGM number 94, press ENTER, the display will show mg/l, suspended solid and the ZERO icon. Blend 500mls of sample in the blender at high speed for exactly 2minutes. Pour the blended sample into a 600ml beaker. Fill a sample cell with n25ml of tape water or deionized water (the blank) place the blank in a cell the holder. Tightly cover the sample cell with the instrument cap. Press ZERO, the cursor will move to the right, and then the display will show 0mg/l suspended solid. Stir the sample thoroughly and immediately pour 25 ml of the blended sample into a sample cell. (The prepared sample). Swirl the prepared sample to remove any gas bubbles and uniformly suspended any residue. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap. Press READ the cursor will move to the right then the result in mg/l suspended solid will be displayed.

3.5 **Chloride Test** (Argentometric method)

Reagents:

1. Potassium chromate indicator solution: dissolve 50g K_2CrO_4 in a little distilled water. Add $AnNO_3$ solution until a definitely red precipitate is formed. Let stand for 12 hours, filter and dilute to 1L with distilled water.
2. Standard silver nitrite titrant, 0.0141m (0.041N): dissolve 2.395g $AgNO_3$ in distilled water and dilute to 1000ml stored in a brown bottle.

Procedure: use a 100ml sample a suitable portion diluted 100ml. if the sample is highly colored, add 3ml $Al(OH)_3$ suspension, mix, let settle and filter. If

1. This sulphate , sulpphide or sulphite is present, add 1ml H_2O_2 and stir for 1minute.
2. Add 1ml K_2CrO_4 indicator solution. Titrate with standard $AgNO_3$ titrant to a pinkish yellow end point. Be consistent recognition.
3. $$Mg\ cl^-/L = \frac{A \times N \times 35{,}450}{Ml\ sample}$$

Where A =ml titration for sample

N= normality of $AgNO_3$ NaCl

Mg NaCl/l = (mgcl$^-$/l) x 1.65

3.6 **Total Hardness** (Tetrimetric method)

REAGENT: buffer solution- dissolve 1.179g EDTA disodium salt and 0.780g $MgSO_4 .7H_2O$ in 50ml distilled water to 16.9g NHCL are 143ml concentration NH4 with mixing and dilute to 250ml with distilled water. Store in tightly stoppered plastic or resistant- glass container.

Eriochrome black T indicator: mix together 0.5g dye and 4.5g hydroxylamine hydrochloric. Dissolve this mixture in 100ml of 95%ethyl or isopropyl alcohol.

Standard EDTA titrant 0.01m-dissolve exactly 3.723g EDTA disodium salt ($Na_2H_2C_{10}D_8N_2$-$2H_2O$) in distilled water and dilute 1L store in a poly ethylene or pyrex bottle.

Procedure:

1. Measure 50ml sample a 125 ml Erlenmeyer flask. Add 2ml buffer (sufficient to give a pH of 10.0-10.1)
2. Add 1-2 drops of indicator and titrate slowly, stirring continuously, until the last reddish tinge disappears from the solution. 1ml 0.01m EDTA should be equivalent to 1mg $CaCO_3$

Calculation:

Total hardness as $CaCO_3$

$$Mg\ CaCO_3/l = \frac{(A-B) \times D \times 1000}{Ml\ sample}$$

Where A= ml of titrant used for the sample

B= ml of titrant used for the blank (use distilled water as blank and treat like the sample) repeat all the procedure for it. Usually, the ml of the titrant used for the blank is always between 0-0.2ml

D= mg C_aCO_3 equivalence to 1.00ml EDTA use

= morality of EDTA x molar mass of calcium carbonate.

CHAPTER FOUR.

4.0 DISCUSSION OF RESULT

Table 2; Analysis before Treatment.

PARAMETERS	UNIT	VALUE
pH	-	4.67
Chemical oxygen demand	mg/l	1,617
Titratable alkalinity	mg/l	190
Total suspended solids	mg/l	174
Chloride	mg/l	437.36
Total hardness	mg/l	595

Table 3; Analysis after Treatment

PARAMETERS	UNIT	VALUE
pH	-	5.80
Chemical oxygen demand	mg/l	78
Titratable alkalinity	mg/l	80
Total suspended solids	mg/l	0.0
Chloride	mg/l	90
Total hardness	mg/l	150

The result obtained and tablelated above is for the water sample collected, tested for pH before and after treatment, chemical oxygen demand(COD) before and after treatment, titratable alkalinity before and after treatment, total suspended solid before and after treatment, chloride test before and after treatment.

The pH, total hardness, total suspended solid, titratable alkalinity, chemical oxygen demand(COD),chloride has the following percentage reduction

For pH = 4.67-5.80/ 4.67 X 100 = -24.197%

For total hardness = 595.53-150/ 595.53 X 100 =74.81%

For total suspended solid = 174-0.0/ 174 X 100 = 100%

For titratable alkalinity = 190-80/ 190 X 100 =57.89%

For chemical oxygen demand= 1617-78/ 1617 X 100 =95.176%

For chloride= 437.36-90/ 437.36 X 100 = 79.42%

This analytical results were obtained by treating 2000ml of waste water collected. The waste water was first treated, which involves the addition of alum to reduced its alkalinity and also coagulate the dissolve solids. Alum and lime used were determine. Alum was 50ml of the solution used (2000ml),the solution was mixed for about 20mins and let to stand to enhance coagulation of the solids. The solution was than filtered. After aeration for odor and microbs to react wit oxygen. Lime of about 30ml was added to finally coagulate and bring and bring the pH to normality. Chlorination to disinfect and reduce the odor after a proper stirring for about 20mins to increase its rate of reaction. The water is filtered through filter paper .

On comparing of the results about before and after treatment shows a great variation, and comparing with the brewery industry standard and standard of drinking water.

pH of the waste water before treatment is 4.67 and after treatment is 5.80 and that of standard value ranges between 6.5-8.5. total hardness of the waste water before treatment is 595.53 and after treatment is 150 and that of standard value is 50mg/l. chloride of the wate water before treatment is 437.36 and after treatment is 90 and that of standard value is 1000mg/l . COD of the wastewater before treatment is 1617 and that after treatment is 78 and the standard value ranges between 25 and 30 mg/L.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the observed parameters, pH, chemical oxygen demand, titratable alkalinity, total suspended solids, chloride, total hardness. It can be concluded that these above parameters are found to have a tremendous deterious effects on the receiving body (Benue River). These effects are due to non compliance with the acceptable national limit set by FEPA and other regulatory body. These lapses are mostly due to inefficiency on the part of the BBl plc treatment plant despite its effort to comply with FEPA set standards.

5.2 Recommendations

From the forgoing, the research work suggest that proper analysis and treatment of waste should be done. this will help in reducing the threat of environmental degradation such as contaimination of water bodies and farming soil around it.

This research work is centered mainly on liquid effluent discharged. More research on both solid and gaseous waste should be conducted to help check its negative effect.

Machines in brewery industries and other process industries should be properly maintained to help reduce waste and noise.

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