TREATMENT OF INDUSTRIAL EFFLUENT USING ZEOLITES: A CASE STUDY OF BIYINZIKA POULTRY SLAUGHTERHOUSE

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A FINAL YEAR RESEARCH AND DESIGN PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND ENVIRONMENTAL ENGINEERING OF UGANDA CHRISTIAN UNIVERSITY

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ABSTRACT

In order to ensure environmental protection, wastewater requires treatment before it is discharged into the environment. This research looks to improve the quality of industrial effluent through treatment using natural zeolites. Samples were collected from Biyinzika poultry slaughterhouse and tests were carried out on them. Preliminary tests indicated high COD, BOD, Turbidity, TN and TP values in comparison to the national standards. The high BOD and COD values were attributed to the high organic loading of the effluent from the plant. This therefore meant that secondary treatment was required aside from the existing wastewater treatment system.

The main objective of this research and the design were achieved. The design consists of a secondary treatment system comprising of zeolites located after the initial treatment processes. This will ensure that the effluent is treated to the required standards before discharge.

The use of natural zeolites increased the efficiency of the treatment process. There was a high percentage reduction in all quality i.e. maximum turbidity, BOD, COD, TN and TP with percentage reductions of 75.7%, 81.3%, 90.8%, 64.2% and 89% respectively. All the quality were also treated to the required standards for discharge therefore implying the main objective the research was achieved.

DECLARATION

I BUSHENDICH JUDAH KWEMOI hereby declare that this research proposal is my original work and has never been submitted to any institution for any award. Any other sources of information referred to are herein duly acknowledged.

Signature: ……………………………… Date: ……………………………….

APPROVAL

This is to certify that this research titled, “Treatment of industrial effluent using zeolites” was carried out under my supervision as the academic supervisor and is now ready for submission for examination.

Mr. RODGERS TAYEBWA

Signature: ……………………… Date:

……………………………………

Supervisor.

ACKNOWLEDGEMENT

First of all, I would like to thank the ALMIGHTY GOD for enabling me complete my final year research and design project successfully.

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DEDICATION

This report is dedicated to my beloved parents and the family members who were very patient with me during the course of this research. Thank you very much for the continued words of encouragement and financial support towards the completion of my final year project research and design.

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LIST OF ABBREVIATIONS

BOD – Biochemical Oxygen Demand

COD – Chemical Oxygen Demand

TN – Total Nitrogen

TP – Total Phosphorous

mg/L – milligrams per litre

NTU – Nephelometric Units

NWSC – National Water and Sewerage Cooperation

NEMA – National Environmental Management Authority

WHO – World Health Organization

UN – United Nations

SBR – Sludge Bioreactor

CHAPTER ONE: INTRODUCTION

1.1 Background and Introduction

Wastewater treatment could be defined as the conversion of wastewater into a form state that could be discharged back into the environment.

There is a global estimation of 80% of produced wastewater being produced being discharged into the environment without sufficient treatment though there is a regional variance. Countries with high-income were found to treat on average about 70% of the wastewater they generate (UN Water, 2019). Globally, about 359 billion cubic meters of wastewater is produced each year, equivalent to 144 million Olympic-sized swimming pools. About 48 percent of that water is currently released untreated. (Edward Jones, 2018) Today, industrial activities generate a significant amount of wastewater, often laden with harmful pollutants. Untreated discharge threatens freshwater resources, ecosystems, and public health. (Tadesse & Guya, 2017) This wastewater typically includes Organic matter like Residual materials from production processes, such as oils, fats, sugars, and starches, Inorganic compounds for example Heavy metals, salts, acids, and alkalis, Pathogens like Bacteria, viruses, and parasites. (Tadesse & Guya, 2017) If left untreated, pose a significant threat to ecosystems, public health, and the overall environmental integrity. Discharging such contaminated water leads to devastating consequences, ranging from aquatic ecosystem degradation to human health risks through polluted water sources. Industrial wastewater treatment projects, therefore, become an indispensable means of mitigating these risks and ensuring environmental compliance.

In Uganda, the primary sources of wastewater are domestic and municipal activities. Annually, approximately 7.62 million cubic meters of wastewater are produced, with nearly half of this volume originating from Kampala alone. The prevalent method of wastewater treatment is primarily of the primary type. However, only around 2% of the population in 22 towns have access to sewerage systems.

Wastewater treatment techniques employed include Conventional Sewage Treatment Works (CSTW), Sewage Stabilization Ponds (SSP), and Constructed Wetlands. Additionally, on a smaller scale, more than 100 roadside florists and horticultural growers in Kampala utilize sludge or dried waste as a soil conditioner, leading to its absorption into the soil. There are also limited instances of wastewater being repurposed for landscaping household lawns. Finally, wastewater is discharged into wetlands for tertiary treatment.

Biyinzika poultry slaughterhouse is a chicken slaughterhouse and packaging industry that is located in Kigunga, Mukono. During the processing of this chicken, massive amounts of water is used for different activities like scalding which involves use of hot water to de-feather the chicken, wash the guts and cut pieces of chicken, cleaning of the slaughter areas and other cleaning activities. At the end of the day, massive amounts of wastewater is generated. This water contains blood, feathers, bird feces, grit, undigested bird food and hence the water isn't safe for discharge into the environment without treatment.

1.2 Problem statement.

At Biyinzika, there exists an activated sludge wastewater treatment system to treat wastewater, this is due to the presence of high organic content in the wastewater and this system is used in the removal of organic matter, and nutrients from wastewater.

An interview with the plant manager revealed that they still weren't meeting the required standards of effluent discharge. Preliminary tests carried out on the effluent found that the values for BOD, COD and Total Nitrogen were 128mg/l, 517mg/l and 20.74mg/l respectively which were above the permissible standards for effluent discharge of 50mg/l, 100mg/l and 10mg/l respectively.

Further treatment is therefore required to be carried out on the water in order for it to meet the required standards. Use of zeolites for adsorption is a very effective way of reduction of nitrates, BOD and COD values in wastewater. They possess a high surface area and its affinity for ions and molecules that make it perfect for use as an adsorbent in treatment of wastewater. (Scott M, 2003) Its availability as a natural resource also makes it much more viable than other alternative adsorbents. (Busulwa, 2023).

1.3 Objectives

1.3.1 Main objective.

The main objective is to treat industrial effluent using zeolites.

1.3.2 Specific objectives

1. To determine the physico – chemical quality of the effluent.

2. To configure the surface properties of natural zeolites using anhydrous ferric chloride.
3. To determine the removal efficiency of natural zeolites in effluent treatment.
4. To design a wastewater treatment system based on adsorption capacity of natural zeolites.

1.4 Justification.

Treating industrial effluent from chicken slaughterhouses is important to protect the environment, comply with regulations and safeguard public health. Effluent from Biyinzika contains blood, fats, feathers and other inorganics. Slaughterhouse effluent is characterized by high levels of organic matter like blood, fats, feathers, and proteins. Untreated discharge can deplete oxygen in water bodies, leading to fish kills and disrupted ecosystems. Treatment removes these pollutants, protecting aquatic life and maintaining healthy waterways.

Nutrients like nitrogen and phosphorus from blood can cause excessive algae growth (eutrophication) in receiving water bodies. This reduces oxygen levels and disrupts the food chain. Treatment removes these nutrients, protecting water quality and biodiversity.

Zeolites possess a high surface area and its affinity for ions and molecules that make it perfect for use as an adsorbent in treatment of wastewater and readily as a natural resource in rocks in Mbale, along river Manafwa, Tiira gold mines in busia and also in Kilembe copper mines. (Busulwa, 2023)

1.5 Geographical Scope

The scope of the study will be Biyinzika poultry slaughterhouse, a chicken slaughterhouse and packaging industry that is located in Kigunga, Mukono. The natural zeolites were obtained from rocks along Manafwa river in Mbale district.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction.

Industrial wastewater must undergo treatment before being discharged to minimize environmental impacts. However, current physical and chemical treatment methods for industrial wastewater have several drawbacks, such as the production of harmful by-products and the need for expensive maintenance. These limitations have resulted in inadequate wastewater management practices within many industries.

2.2 Physical and chemical quality of industrial wastewater.

Industrial wastewater from food processing industries can vary widely in its physical and chemical quality, some common characteristics include:

2.2.1 Physical quality

2.2.1.1 Color

Wastewater can range in color from clear to dark brown or black, depending on the type of food being processed and the presence of suspended solids and other pollutants. For example, wastewater from fruit and vegetable processing industries is often brightly colored due to the presence of natural pigments, while wastewater from meat and poultry processing industries is often dark in color due to the presence of blood and other organic matter.

2.2.1.2 Odor

Wastewater often has a strong, unpleasant odor due to the presence of organic matter and bacteria. The odor can vary depending on the type of food being processed, but it is often described as being similar to rotting food or garbage.

2.2.1.3 Temperature

Wastewater can be warmer than ambient temperature due to the use of hot water in the processing process. For example, wastewater from blanching operations is typically high in temperature.

2.2.1.4 Turbidity

Wastewater can be turbid, or cloudy, due to the presence of suspended solids. Suspended solids can include food particles, debris, and microorganisms.

2.2.1.5 Total solids (TS)

TS refers to the total amount of suspended and dissolved solids in wastewater. Wastewater typically has high TS levels due to the presence of organic matter and other pollutants.

2.2.1.6 Suspended solids (SS)

SS refers to the number of solids that are suspended in wastewater and can be filtered out. Wastewater typically has high SS levels due to the presence of particles and other debris.

2.2.2 Chemical quality

2.2.2.1 pH

The pH of food processing wastewater can range from acidic to alkaline, depending on the type of food being processed and the presence of chemicals used in the processing process. For example, wastewater from fruit and vegetable processing industries is often acidic due to the presence of organic acids, while wastewater from meat and poultry processing industries is often alkaline due to the presence of cleaning and sanitizing agents.

2.2.2.2 Biological Oxygen Demand, BOD

BOD, or biological oxygen demand, is a measure of the amount of dissolved oxygen needed by aerobic microorganisms to break down organic matter in water over a specific time period, usually five days. BOD is an important quality for industrial wastewater because it can have a negative impact on the receiving environment. (Metcalf & Eddy, 2004).

When industrial wastewater with a high BOD is discharged into a river or lake, the microorganisms in the water will consume the dissolved oxygen to break down the organic matter. This can lead to a decrease in dissolved oxygen levels, which can harm or kill aquatic life.

The nutrients that lead to high BOD are nitrogen and phosphorus. These nutrients are essential for plant growth, but when they are present in excess in water bodies, they can lead to eutrophication. Eutrophication is a process in which excessive amounts of nutrients promote the growth of algae and other aquatic plants. When these plants die and decompose, they consume oxygen in the water, leading to low dissolved oxygen levels.

BOD is a surrogate measure of the amount of organic matter in water. It is not a direct measure of the concentration of specific organic compounds. BOD is expressed in milligrams of oxygen consumed per liter of water (mg/L). A higher BOD indicates a greater amount of organic pollution in the water (Whiting, 2017).

When BOD levels are high, microorganisms can consume all of the dissolved oxygen in the water, which can lead to hypoxia or anoxia. Hypoxia and anoxia are conditions in which the dissolved oxygen concentration in the water is too low to support aquatic life.

High BOD levels can also lead to the growth of harmful bacteria, such as E. coli and Salmonella which can be cause diseases for both animals and humans on consumption this water.

2.2.2.3 Chemical oxygen demand (COD)

Chemical oxygen demand (COD) is a measure of the amount of oxygen required to oxidize all oxidizable compounds in a measured sample of effluent. COD is used to gauge the short-term impact wastewater effluents will have on the oxygen levels of receiving waters (Metcalf & Eddy, 2004).

COD is a more comprehensive measure of the organic content of wastewater than BOD because it includes both biodegradable and non-biodegradable organic matter. BOD only measures the biodegradable organic matter that can be broken down by microorganisms.

COD is measured by chemically oxidizing all of the organic matter in a sample of wastewater. This is typically done using a strong oxidizing agent, such as potassium dichromate, and a catalyst, such as silver sulfate. The amount of oxygen required to oxidize the organic matter is then measured.

COD is expressed in milligrams of oxygen consumed per liter of water (mg/L). A higher COD indicates a greater amount of organic matter in the water.

COD is an important quality in industrial wastewater because it can have a significant negative impact on the receiving environment if not properly managed. When industrial wastewater with a high COD is discharged into a river or lake, the microorganisms in the water will consume the dissolved oxygen to break down the organic matter. This can lead to a decrease in dissolved oxygen levels, which is harmful to aquatic life. Low dissolved oxygen levels can cause fish kills, disrupt aquatic ecosystems, and promote the growth of harmful bacteria.

2.2.2.4 Turbidity.

Turbidity in industrial wastewater is the cloudiness or haziness of the water caused by suspended solids or tiny particles. These particles can be organic or inorganic, and they can range in size from a few microns to several millimeters.

Turbidity is an important quality in industrial wastewater because it can have a significant impact on the treatment process and the quality of the treated effluent. High turbidity can interfere with the effectiveness of treatment processes such as sedimentation, filtration, and disinfection. It can also make it difficult to monitor and control other treatment processes (Metcalf & Eddy, 2004).

Turbidity can also have a negative impact on the quality of the treated effluent. High turbidity can make the effluent more difficult to reuse and can also make it more toxic to aquatic life.

Turbidity is an important quality in industrial wastewater because it can have a significant impact on the treatment process and the quality of the treated effluent. Industrial facilities should monitor turbidity levels in their wastewater and take steps to reduce turbidity as needed. By doing so, they can protect the environment and comply with environmental regulations.

Table 1: NEMA standards on industrial effluent discharged (NEMA, 1999)

Quality	Standards for effluent discharged	units
BOD	50	mg/l
COD	100	mg/l
Turbidity	300	NTU
pH	6.0-8.0	
TN	10	mg/L
TP	10	mg/L

2.3 Treatment of wastewater

2.3.1 Use of natural zeolite in treatment.

Natural zeolites can be used to reduce the concentrations of BOD and COD in industrial wastewater by adding it as a filter media in a multi-media filter. Natural zeolites are crystalline aluminosilicates with a unique porous structure that can adsorb various substances, making them effective in treating industrial wastewater. (Fernandes , et al., 2022)

Zeolites are naturally occurring minerals typically found filling fractures and pores in volcanic rocks, leading to the formation of significant deposits. Volcanic rocks serve as the primary precursor materials for zeolite formation, although other minerals such as feldspars, kaolinite, smectite, volcanic glass, or even existing zeolites can play a similar role, depending on factors like pressure, temperature, and the presence of mineralizing fluids within a dissolution-precipitation system. (Fernandes , et al., 2022)

The processing of zeolitic ore involves comminution steps and grading by particle size ranges. Out of the 60 varieties of natural zeolites, only clinoptilolite, analcime, heulandite, laumonite, phillipsite, mordenite, chabazite, erionite, and ferrierite have significant known sedimentary reserves. (Fernandes , et al., 2022)

In contrast to synthetic zeolites, natural ones exhibit a diverse range of mineralogical and chemical compositions, crystal structures, and pore sizes, limiting their application in cases where more uniform properties are necessary for high efficiency. However, natural zeolites are less expensive than synthetic counterparts, making them suitable for applications such as animal feed production, water treatment, odor control, gas adsorption, and as pozzolanic additives in Portland cement. (Fernandes , et al., 2022)

2.3.1.1 Adsorption

Zeolites have a high surface area and cation exchange capacity. They can adsorb organic compounds from wastewater, reducing both BOD and COD. The porous structure of zeolites allows them to trap organic molecules effectively.

2.3.1.2 Ion Exchange

Zeolites can exchange ions with substances in wastewater. This ion exchange process can remove certain organic pollutants and heavy metals, contributing to the reduction of BOD and COD.

2.3.1.3 Catalytic Oxidation

Zeolites can act as catalysts in advanced oxidation processes. They can facilitate the breakdown of organic pollutants into simpler, less harmful substances through processes like Fenton oxidation or catalytic wet air oxidation, reducing both BOD and COD.

2.3.1.4 Microbial Immobilization

Zeolites can serve as carriers for microorganisms. These microorganisms can be specific bacteria or fungi that naturally degrade organic pollutants. The zeolite provides a suitable environment for these microorganisms to thrive and break down organic compounds, thereby reducing BOD and COD.

2.3.1.5 pH Adjustment

Zeolites can help in stabilizing the pH of the wastewater. Controlling the pH is crucial for the efficiency of biological treatment methods. Zeolites can act as buffers, preventing drastic pH changes that can inhibit biological treatment processes.

By integrating natural zeolites into multi-media filters and considering these factors, industrial wastewater can be effectively treated, reducing BOD and COD levels and ensuring compliance with environmental regulations.

2.3.2 Modification of natural zeolites for use.

The enhancement of natural zeolites involves a series of chemical processes aimed at improving their properties. Chemical treatments involving acids and/or bases are employed to eliminate impurities that obstruct the pores, thereby enhancing the cation exchange capacity. (Fernandes , et al., 2022)

Another method of modifying zeolites involves the use of organic surfactants, which create a monolayer on the zeolite surface. Quaternary amines are commonly used for this purpose, acting as cationic reagents that enable the zeolites to adsorb anions. (Fernandes , et al., 2022)

2.3.3 Methods of wastewater treatment.

2.3.3.1 Activated sludge treatment.

This process utilizes biological growth circulated to the system interact with the wastewater in the presence of oxygen. The process involves an aeration process followed by solid liquid separation one from which the separated sludge is recycled for remixing with the influent waste. The aeration- step consists of rapid absorption of substrate, progressive oxidation and further aeration resulting in oxidation. (Andrade, 1974). The process involves four steps which are primary sedimentation, aeration, separation of biologically active sludge and return of sludge for remix with the raw incoming waste.

Activated sludge treatment of wastewater is a biological process that uses microorganisms to remove organic matter from wastewater. The process was first developed in the early 1900s, and it is now the most common method of secondary wastewater treatment in the world.

The activated sludge process is a two-stage process. In the first stage, wastewater is mixed with a suspension of microorganisms called activated sludge. The microorganisms feed on the organic matter in the wastewater, and they produce new cells and carbon dioxide.

In the second stage, the activated sludge is separated from the treated wastewater in a settling tank. The activated sludge is then recycled back to the first stage, where it can continue to treat more wastewater.

The activated sludge process is a very effective method of removing organic matter from wastewater. It can typically remove 85-95% of the biochemical oxygen demand (BOD) from wastewater. The process can also be modified to remove nitrogen and phosphorus from wastewater.

2.3.3.2 Anaerobic treatment method.

Anaerobic decomposition of dissolved organic matter is affected by bacteria which utilize the oxygen present in the organic matter properly to decompose it. The presence of dissolved molecular oxygen is not required for the process and as a matter of fact, were it present anaerobic organisms would become extinct (Buzzini, et al., 2006).

Anaerobic treatment may be described as a three-step process involving the hydrolysis of complex organic substances, the production of acids and the fermentation of organic acids into gaseous products mainly methane and carbon dioxide (Andrade, 1974).

Anaerobic treatment of wastewater is a biological process that uses microorganisms to remove organic matter from wastewater in the absence of oxygen. The process is much slower than activated sludge treatment, but it is also more energy-efficient and can produce methane gas, which can be used as a renewable energy source.

Anaerobic treatment of wastewater is typically used in two stages. In the first stage, the wastewater is mixed with a suspension of microorganisms called anaerobic sludge. The microorganisms feed on the organic matter in the wastewater, and they produce methane gas, carbon dioxide, and new cells.

In the second stage, the anaerobic sludge is separated from the treated wastewater in a settling tank. The anaerobic sludge is then recycled back to the first stage, where it can continue to treat more wastewater.

Anaerobic treatment of wastewater is a very effective method of removing organic matter from wastewater. It can typically remove 85-95% of the biochemical oxygen demand (BOD) from wastewater. The process can also be modified to remove nitrogen and phosphorus from wastewater.

2.4 Addition of zeolites to each of this treatment methods.

2.4.1 Activated sludge treatment

2.4.1.1 Adding zeolite granules to the aeration basin:

Zeolite granules can be added to the aeration basin as a single dose or they can be added continuously.

If adding zeolite granules as a single dose, the granules should be dispersed evenly throughout the aeration basin. This can be done by adding the granules to the influent wastewater or by manually adding the granules to the aeration basin.

If adding zeolite granules continuously, a zeolite feeder can be used. The zeolite feeder will add the zeolite granules to the aeration basin at a predetermined rate.

Adding a zeolite filter downstream of the aeration basin:

A zeolite filter can be placed downstream of the aeration basin to remove suspended solids and other pollutants from the wastewater.

The zeolite filter should be sized appropriately for the flow rate of the wastewater.

The zeolite filter should be backwashed regularly to remove accumulated solids.

2.4.2 Anaerobic treatment:

2.4.2.1 Adding zeolite granules to the anaerobic digester:

Zeolite granules can be added to the anaerobic digester as a single dose or they can be added continuously.

If adding zeolite granules as a single dose, the granules should be dispersed evenly throughout the anaerobic digester. This can be done by adding the granules to the influent wastewater or by manually adding the granules to the anaerobic digester.

If adding zeolite granules continuously, a zeolite feeder can be used. The zeolite feeder will add the zeolite granules to the anaerobic digester at a predetermined rate.

2.4.2.2 Adding a zeolite biofilm carrier to the anaerobic digester:

A zeolite biofilm carrier can be placed in the anaerobic digester to increase the surface area available for microorganisms to grow on.

The zeolite biofilm carrier can be added to the anaerobic digester as a single dose or they can be added continuously.

If adding zeolite biofilm carrier as a single dose, the carrier should be dispersed evenly throughout the anaerobic digester. This can be done by adding the carrier to the influent wastewater or by manually adding the carrier to the anaerobic digester.

If adding zeolite biofilm carrier continuously, a zeolite feeder can be used. The zeolite feeder will add the zeolite biofilm carrier to the anaerobic digester at a predetermined rate.

CHAPTER THREE: METHODOLOGY.

3.1 Sample collection.

Grab sampling was used to collect the waste water samples. Grab sampling is a sampling technique in which a single sample or measurement is taken at a specific time or over a short period of time. The sampling was done at Biyinzika poultry slaughterhouse. The sampling was done three times in a day on three different days. The sampling was done at morning, noon and evening.

3.2 Determination of the physico – chemical quality of the effluent.

3.2.1 Chemical quality

3.2.1.1 Biochemical Oxygen Demand.

A portion of the sample is transferred to a bottle, and the initial dissolved oxygen (DO) concentration is measured using a dissolved oxygen meter. The sample is then incubated in darkness at a controlled temperature, usually 20°C, for a specified duration, typically 5 days.

During the incubation period, microorganisms in the sample consume the organic matter present, thereby depleting the dissolved oxygen. After the incubation period, the final dissolved oxygen concentration is measured using the same method as the initial measurement.

The BOD of the effluent sample is calculated as the difference between the initial and final dissolved oxygen concentrations, taking into account any oxygen consumed by a blank sample (a sample without organic matter) incubated under the same conditions.

The BOD value is expressed in milligrams of oxygen per liter (mg/L) or parts per million (ppm) of water.

3.2.1.2 Chemical Oxygen Demand.

Reagents are prepared, including a potassium dichromate ($K_2Cr_2O_7$) solution, which serves as the oxidizing agent, and a silver sulfate (Ag_2SO_4) solution, acting as a catalyst.

Next, the wastewater sample is placed into a digestion tube or flask, followed by the addition of the prepared $K_2Cr_2O_7$ solution and Ag_2SO_4 catalyst. The vessel is sealed to prevent the escape of volatile compounds during the reaction. Subsequently, the mixture is heated in a digestion apparatus at a temperature of 150-170°C for 2 hours, to oxidize the organic matter.

After digestion, the mixture is cooled to room temperature. Excess $K_2Cr_2O_7$ is titrated with a standard solution of ferrous ammonium sulfate ($Fe(NH_4)_2(SO_4)_2$) using a suitable indicator (e.g., ferroin), with the endpoint marked by a color change from orange to green.

Finally, the COD of the wastewater sample is calculated using the volume and concentration of the ferrous ammonium sulfate solution used in the titration, along with any dilution factors applied during the analysis.

$$\text{COD as mg } O_2/L = \frac{\text{mg}O_2 \text{ in final vol X 1000}}{\text{mL sample}}$$

3.2.2 Biological quality

3.2.2.1 Total Nitrogen.

Total nitrogen (TN) in wastewater is typically determined using a method called the Kjeldahl method. Here, the sample is digested in the presence of a strong acid (sulfuric acid) and a catalyst (usually a metal such as selenium). This step converts the organic and inorganic nitrogen compounds into ammonium sulfate. The ammonia released from the digestion is distilled off and collected in a known volume of boric acid solution, where it forms ammonium borate.

The amount of ammonia present in the distillate is determined by back-titration with a standard solution of sulfuric acid. The endpoint of the titration is typically detected using a pH indicator or a pH meter. The total nitrogen content in the sample is calculated based on the volume and concentration of the standard acid used in the titration, as well as the dilution factor and the volume of the original sample.

3.2.2.2 Total phosphorous.

To determine total phosphorus in effluent in the future tense, the following steps will be undertaken:

Reagents required for total phosphorus determination, including digestion reagents if necessary, will be prepared according to standardized protocols. This may involve preparing acid solutions for digestion and reagents for phosphorus analysis.

If the digestion will be performed to convert all phosphorus species to orthophosphate. This may involve using acid digestion or persulfate digestion methods.

A measured volume of the digested or undigested effluent sample will be transferred into clean test tubes.

A suitable phosphorus reagent, such as ammonium molybdate, will be added to the sample. The ratio of sample to reagent will be adjusted based on expected phosphorus concentrations.

The mixture will be thoroughly mixed and allowed to react for a specified period to form the molybdenum blue complex.

Following the reaction period, a reducing agent solution will be added to the test tubes to develop a blue coloration.

The absorbance of the solution at a specific wavelength, typically around 700-800 nm, will be measured using a spectrophotometer.

A calibration curve will be prepared using standard phosphate solutions of known concentrations. This curve will establish the relationship between absorbance and phosphorus concentration.

The absorbance of the effluent samples will be compared to the calibration curve to determine the concentration of total phosphorus in the effluent.

Blank samples (containing all reagents except the sample) and standard reference samples will be run alongside the effluent samples to ensure accuracy and precision.

3.2.3 Remodeling of zeolite.

The zeolite rocks will first be crushed with a mallet hammer to decrease their size, followed by further crushing using a Manual Aggregate Crushing Value (ACV) machine.

The resulting crushed zeolite will then undergo sieving to achieve particle sizes ranging from 0.15 to 0.3mm. To remove any foreign materials, the sample will be water-washed and subsequently dried in an oven at 70°C for 12 hours before being stored in polythene bags to prevent dust contamination.

Next, 800 grams of zeolite will be mixed with a 1000 cm3 aqueous solution of anhydrous ferric chloride (FeCl3) with a concentration of 21.36 g/dm3 at 25°C. After stirring for 15 minutes, the mixture will be left to stand for 24 hours. Following filtration, the iron (III)-modified zeolite will be washed with distilled water until Cl− ions are no longer detectable using the silver nitrate test. The modified sample will then be dried at 70°C for 12 hours and stored in polythene bags within a sealed plastic container to prevent potential contamination. (Turyasingura & Kantuntu, 2023)

3.2.4 Determination of removal efficiency of Zeolites.

Tests for values of total nitrogen, pH, COD, BOD will be carried out and compared with national standards for effluent discharge after treatment.

The ph test with be carried out using the APHA 4500-H B method. This is an electrical method that uses a standard hydrogen electrode and reference electrode to measure the activity of the hydrogen ions.

BOD will be determined by the BOD_5 test method. The sample will be prepared and DO determined then the sample is allowed to stay for 5 days where the OD will be determined again. The difference will then be found and that will be the value of BOD.

The obtained values after the zeolite treatment will be denoted as Ci and the initial results for the waste water quality be denoted as Ce.

Adsorption capacity of the zeolite will be obtained from the following formula.

Adsorption capacity $= \frac{Ci-Ce}{Ci} \times 100$ (Reagan, 2019)

3.2.5 Design of treatment system.

The discharge values were acquired from the plant records. Optimum depth of the zeolite from the prototype was 0.25 m. Velocity of the water was obtained by first measuring the time of travel using a bottle top. (Aziz & Mustafa, 2019)

The bottle top was set to travel through a known distance of 50m and the time was recorded on 3 different occasions and an average obtained.

Velocity was then got by

$$v = \frac{distance}{time}$$

Discharge or flow rate is got from;

$$Q = v\,A$$

Where;

v is velocity

A is area

To size the column, in which the zeolite treatment at the site is to be done;

$$V = \Pi r^2 h$$

CHAPTER FOUR: RESULTS AND DISCUSSION.

4.1 INTRODUCTION

Analysis was carried out on the wastewater from the poultry slaughterhouse. The data was collected on three different days and the average for each time was determined while showing the deviation from the mean value.

Treatment was carried out on where the peak hour from the results which was afternoon was were passed through the experimental setup. The depths of the column in the setup was varied so as to vary contact time since the efficiency of the zeolites highly depended on the contact time of the zeolites with the wastewater.

The results of the studies carried out were then analyzed below.

4.2 DETERMINATION OF THE PHYSICO CHEMICAL QUALITY OF THE WASTEWATER

4.2.1 CHEMICAL OXYGEN DEMAND. COD.

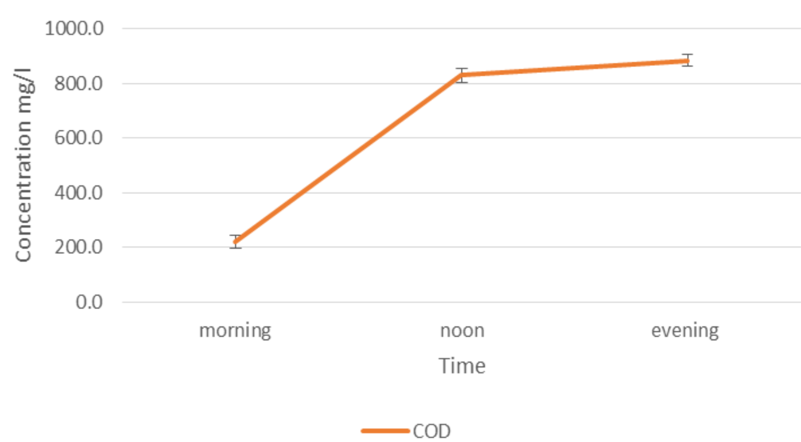

Figure 1: Variation of concentration of COD throughout the day.

The COD value was 219.7±4mg/L in the morning. This was the lowest value of COD recorded, which is above the permissible standards of 70 mg/l. During morning hours, the slaughter of chickens at Biyinzika hasn't yet started. The COD is at this value because of chemicals like detergent used in cleaning the area after chickens were slaughtered the previous evening.

It rose to 829.1±15mg/L in the afternoon because of the use of an antibacterial concoction that is smeared on the chicken flesh straight after cutting. The chickens are also injected with sodium lactate and potassium lactate which are meant to strengthen the shell life of the poultry, as well as fight contaminants.

In the evening, the COD Value was 884.8±7mg/L. The chicken are injected with Bromelain and Ficin to tenderize the meat. The use of chemicals in these processes increases the COD in the effluent.

4.2.2 BIOLOGICAL OXYGEN DEMAND. BOD

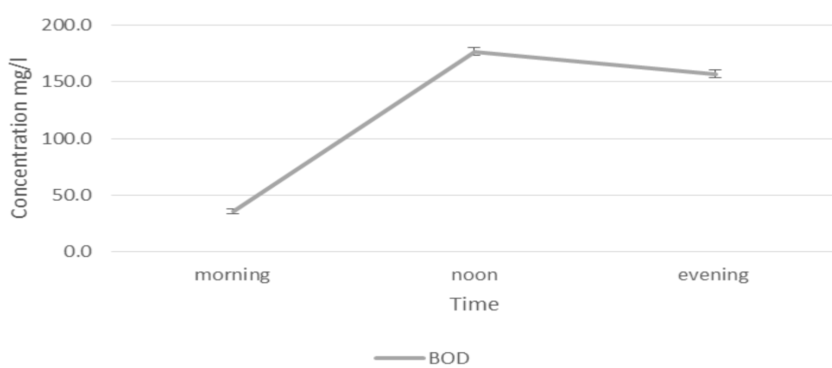

Figure 2 : Variation of BOD concentration throughout the day.

In the morning, the BOD value was 34.5±2mg/l. In the morning the slaughterhouse is at its least operating power and hence the low BOD. There are few organics like feathers and blood which lead to the BOD.

In the afternoon the BOD value was 176.8±3mg/l. in the afternoon, the slaughter house is at its operating peak hence the generation of a high BOD value. There is a hifh and 156.9±3mg/l in the evening. The values for the afternoon and evening were above the permissible effluent standards of 50 mg/l. In the afternoon, the slaughterhouse is at its operational peak and hence the optimum BOD results. At this time organic matter like feathers, blood and other residue are found in the effluent and hence the high BOD. In the evening the organic matter still leads to a high BOD.

4.2.3 TOTAL NITROGEN, TN.

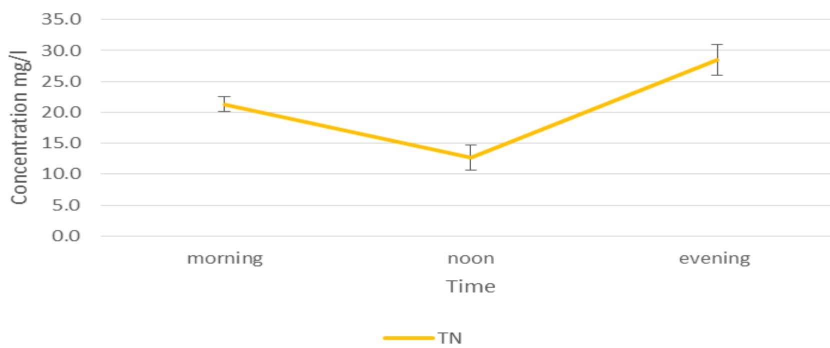

Figure 3: Variation of concentration of Total Nitrogen throughout the day.

The morning values for TN were 21.3±1 mg/L which meant that the nitrification process was not efficient at these times. This was attributed to the presence of high volumes of organic content at these hours due to the chicken droppings and blood from the slaughtering processes which were established to being carried out at these times.

The afternoon values for TN were 12.7±2 mg/L which meant that the nitrification process was of better efficiency as compared to the morning times. This therefore meant the slaughtering activities of the chicken had reduced and different activities were being carried out that didn't overload the plant.

The evening values for TN were 28.5±2 mg/L which meant that the nitrification process was not efficient at these times. This was attributed to the presence of high volumes of organic content at these hours due to the washing of the chicken before packaging was done therefore the wastewater contained high volumes of blood.

4.2.4 TOTAL PHOSPHOROUS, TP.

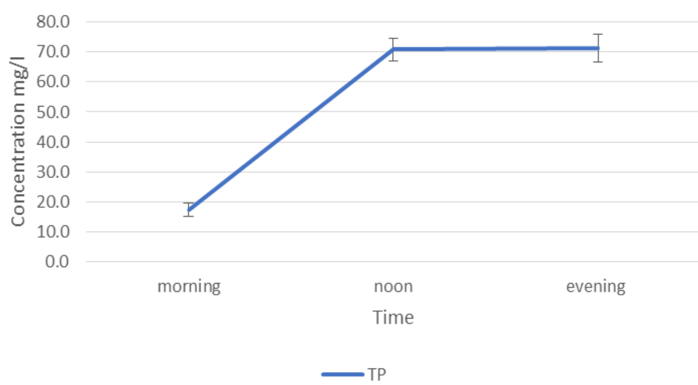

Figure 4 : Variation of concentration of Total Phosphorous throughout the day.

Total phosphorous was found to be in non-compliance with the UNBS standard of effluent discharge of 5mg/L. The total phosphorous value is 17.4±2 mg/L in the morning due to the use of cleaning and disinfection chemicals used such as phosphates and phosphoric acid contribute to the total phosphorus level in the wastewater. These chemicals are used for sanitation purposes to control bacteria and other microorganisms. In the afternoon the Total Phosphorous increased to 70.8±4 due to the presence blood and offal in the waste water, the internal organs removed during slaughtering chicken, are rich in phospholipids and other phosphorus-containing compounds. When these materials enter the wastewater stream during cleaning and processing, they elevate the total phosphorus content

In the evening the Total Phosphorous value was 71.4±4 mg/. This is attributed to the heavy use of chemicals and detergents during the industry processes of cleaning and preservation of the chicken after slaughter. These chemicals often contain phosphorous compounds. The cleaning processes especially generated the highest amounts of wastewater that contained detergents which explained the high values of TP. In addition to that Chickens naturally contain phosphorus in their bones, muscles, and other tissues, essential for various biological functions like energy storage and building cell membranes. During the slaughtering process, processing activities like scalding, evisceration, and cleaning release these phosphorus-containing materials into the wastewater

4.2.5 TURBIDITY

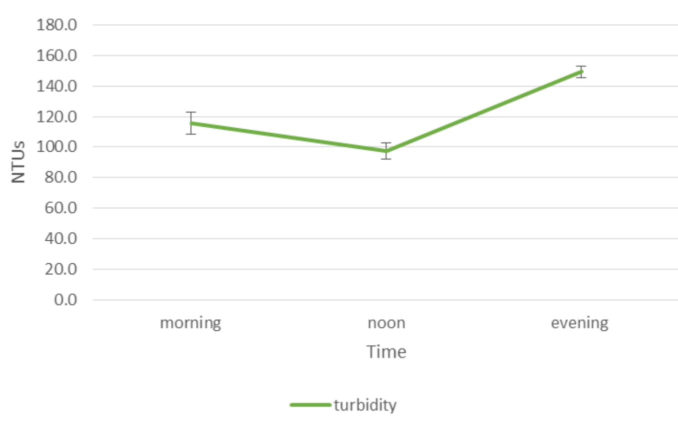

Figure 5 : Variation of turbidity throughout the day

In the morning the Turbidity value was 115.7 due to the presence of blood in the waste water. During slaughtering, blood is released from the chickens, contributing significantly to the suspended solids in the wastewater and hence making the water turbid.

In the afternoon the turbidity was 97.3 due to the presence of Feathers. Feathers, even after plucking, can remain in the processing water, leading to increased turbidity.

In the evening the turbidity was 149.5 due to the presence of Skin and other tissue fragments. Small pieces of skin, fat, and other tissue fragments can become suspended in the water during processing and contribute to turbidity.

4.2.6 pH

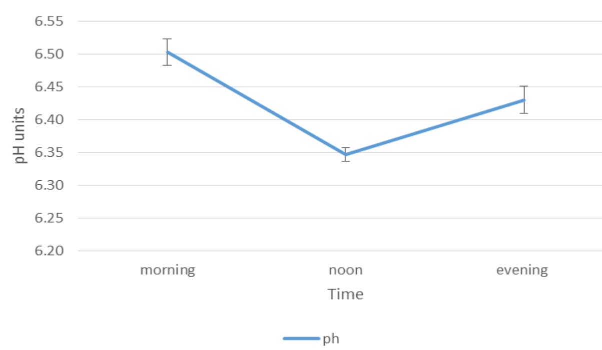

Figure 6: Variation of pH throughout the day.

In the morning the pH is 6.50 as both acids and bases are used in various processes of the chicken slaughtering. Acids like citric acid and acetic acid, are commonly used during the slaughtering process for various purposes, including:

In the afternoon the pH is 6.35 as more water and buffer solutions are used to clean up the areas where chickens are slaughtered. These are alkaline in nature and cause a drop in the pH. The afternoon hours are the peak operating times of the slaughterhouse.

In the evening, the pH is 6.43. Chicken meat naturally has a slightly acidic pH due to the presence of lactic acid, a byproduct of muscle metabolism. During the slaughtering process, this natural acidity is released from the muscles, contributing to the overall environment's acidity. This acidity of the meat leads to a rise in the pH.

4.3 DETERMINATION OF PERCENTAGE REMOVAL FOR ZEOLITES.

Table 2: Table showing removal for different zeolite depths

	15cm	20cm	25cm
COD	81.1	86.4	90.8
BOD	61.2	72.3	81.3
TN	30.5	50.5	64.2
TP	70.0	85.0	89.0
Turbidity	37.7	54.1	75.7

The wastewater was passed through zeolites of depths 15cm, 20cm and 25cm to vary contact time. Three different trials were carried out and the average for the results obtained were determined. The removal efficiency was then obtained by comparison with the peak hour values of the effluent. The results above were obtained.

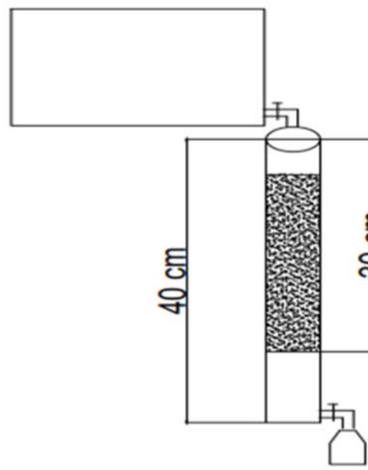

Figure 7: Experimental setup.

4.3.1 TURBIDITY

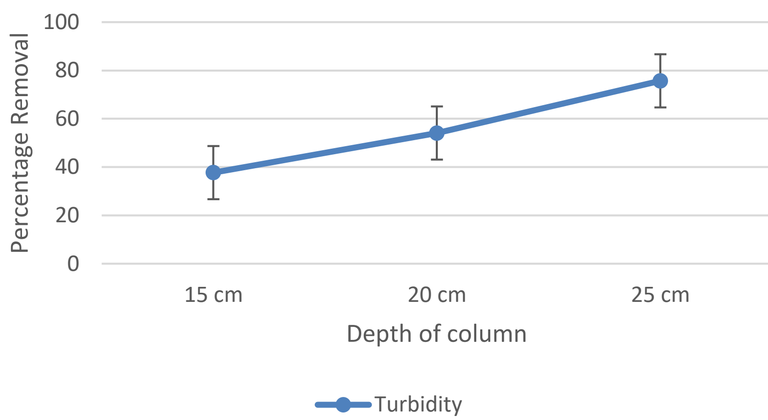

Figure 8 : Percentage removal variation for Turbidity

At 15 cm depth of column, the percentage removal of turbidity is 37.7% because zeolites have a high surface area and a network of pores that can adsorb suspended particles, including organic matter and colloidal particles, which contribute to turbidity. The porous structure of zeolites allows them to trap these particles, reducing turbidity in the effluent.

At 20 cm depth of column, the percentage removal of turbidity is 54.1% because zeolites have a negatively charged framework that can exchange cations (positively charged ions) with the surrounding solution. This property can help in removing heavy metal ions and other cations that contribute to turbidity by forming colloidal particles.

At 25 cm depth of column, the percentage removal of turbidity is 75.7 % because zeolites can act as a filtration medium, physically trapping suspended particles as the wastewater flows through the porous structure of the zeolite bed. This mechanism helps in reducing turbidity by removing particles from the effluent.

4.3.2 BOD

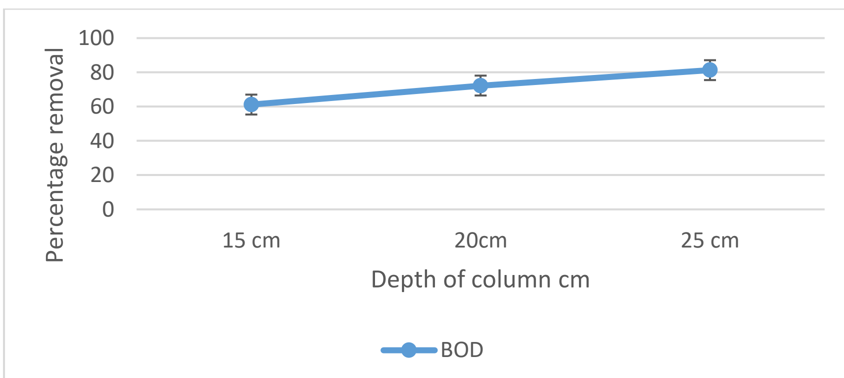

Figure 9: Percentage removal of BOD

At 15 cm depth of column, the percentage removal of BOD is 61.2% because zeolites can adsorb organic compounds onto their surface, effectively removing them from the water. This includes organic matter contributing to BOD, such as proteins, fats, and other organics present in chicken slaughterhouse effluent.

At 20 cm depth of column, the percentage removal of BOD is 72.3% because zeolites can act as catalysts for certain chemical reactions that break down organic compounds into simpler, less harmful substances. This can help in reducing the organic load and consequently the BOD of the effluent.

At 25 cm depth of column, the percentage removal of BOD is 81.3% because Zeolites can also act as a filtration medium, physically trapping suspended solids and organic matter in the effluent, which can contribute to BOD.

4.3.3 TOTAL NITROGEN

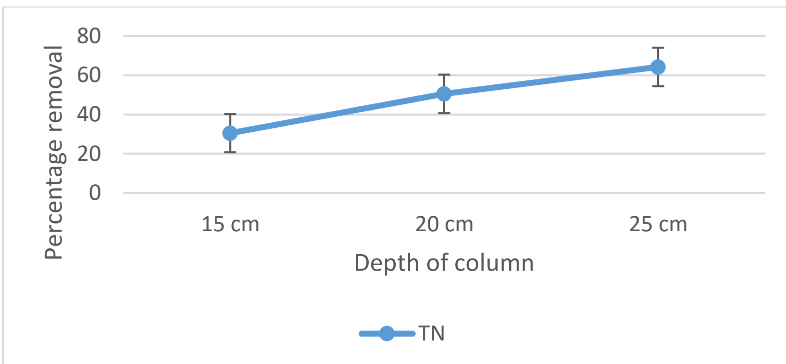

Figure 10 : Percentage removal variation of TN

At 15 cm depth of column, the percentage removal for Total Nitrogen is 30.5% because zeolites have a high surface area and cation exchange capacity, allowing them to adsorb ammonium ions (NH4+) from the wastewater. Ammonium is a significant contributor to TN in wastewater.

At 20 cm depth of column, the percentage removal for Total Nitrogen is 50.5% because zeolites can provide a surface for nitrifying bacteria to attach and grow.

These bacteria convert ammonium to nitrite (NO2-) and then to nitrate (NO3-), which can be removed through subsequent treatment processes.

At 25 cm depth of column, the percentage removal of Total Nitrogen is 64.2% because zeolites can exchange cations in their structure with ammonium ions in the wastewater, effectively removing them from the water phase.

4.3.4 COD

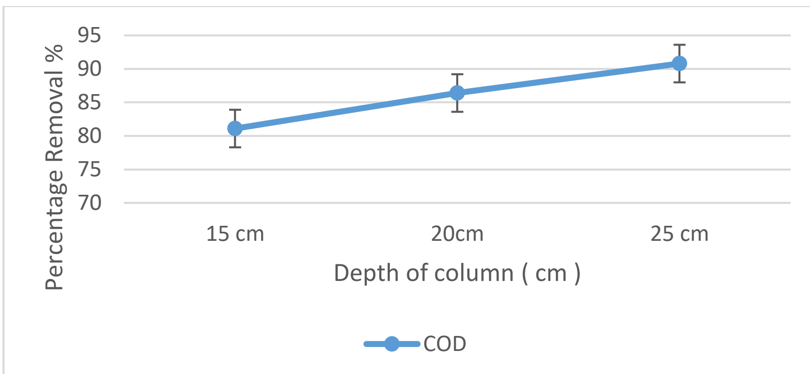

Figure 11 : Percentage removal variation of COD

At 15 cm depth of column, the percentage removal of COD is 81.1% because zeolites can also participate in ion exchange processes. They can trap ammonium ions (NH4+), a common component in slaughterhouse wastewater originating from animal waste. By removing these nitrogen-containing ions, zeolites indirectly contribute to COD reduction as nitrogenous compounds also contribute to the overall COD value.

At 20 cm depth of column, the percentage removal of COD is 86.4 % because Zeolites are natural minerals with a cage-like structure formed by aluminum, silicon, and oxygen. This structure creates a large internal surface area with cavities and channels to reduce COD.

At 25 cm depth of column, the percentage removal of COD is 90.8% because zeolites can act as catalysts for certain chemical reactions that break down organic compounds into simpler, less harmful substances. This can help in reducing the organic load and consequently the BOD of the effluent.

4.3.5 TOTAL PHOSPHOROUS

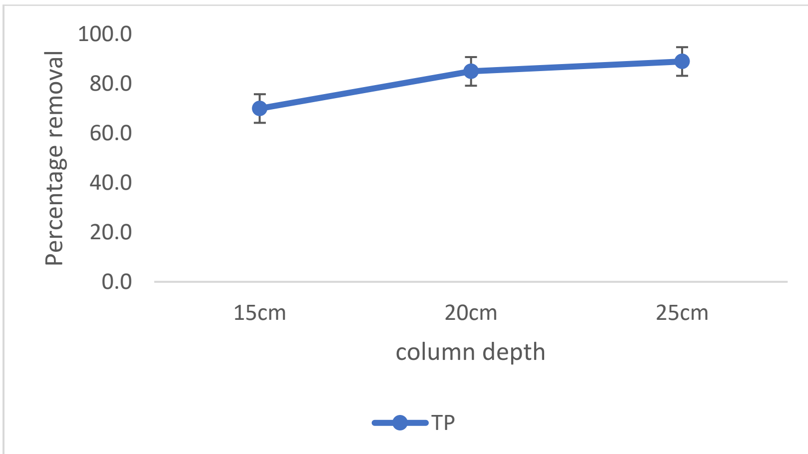

Figure 12 : Percentage removal variation of TP

At 15 cm depth of column, the percentage removal of Total Phosphorous is 70.0% because as wastewater flows through the zeolite media, ammonium ions ($NH4^+$) from organic matter in the wastewater are attracted to the zeolites negatively charged cavities.

At 20 cm depth of column, the percentage removal of Total Phosphorous is 85% because phosphate ions ($PO4^{3-}$) present in the wastewater can interact with the zeolite's internal structure and become adsorbed onto the zeolite surface.

At 25 cm depth of column, the percentage removal of Total Phosphorous is 89% because whereas zeolites attract cations, they can also selectively bind to phosphate

($PO4^{3-}$), a major component of TP. This occurs because the zeolite framework can interact with the phosphate molecule through electrostatic forces and hydrogen bonding.

4.4 DESIGN

The data acquired from the set up is then used to come up with the design for the wastewater treatment system along with the existing plant. The theory of linear similarity was applied to the dimensions of the set up we used to upscale the column to the existing system. (Aziz & Mustafa, 2019)

Column information.

- ✓ Diameter=5cm
- ✓ Depth=25cm
- ✓ Flow rate for the setup =0.015m^3/s
- ✓ Plant flow rate = 5m^3/s

Scale up factor= $\frac{5}{0.015}$

=1000/3

$$System\ diameter = prototype\ diameter \times \sqrt{scaleup\ factor}$$

$$System\ diameter = 0.05 \times \sqrt{\frac{100}{3}}$$

$$system\ diameter = 0.91m \approx 1m$$

$$System\ depth = \ prototype\ depth \times \sqrt{scaleup\ factor}$$

$$System\ depth = \ 0.25 \times \sqrt{\frac{100}{3}}$$

$$System\ depth = 4.57m \approx 5m$$

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS.

5.1 CONCLUSIONS

From the first objective, the peak operating time of the slaughterhouse was noon as it gave us the highest values of most quality. In the morning, the slaughterhouse is at its least operational power and hence most quality is at low values. In the evening, the values tend to rise compared to the evening, but most quality peak at the noon hours and hence it is our peak time. This therefore meant that at these times of the day, the water released into the environment was not up to the required standards. This therefore meant that treatment of the wastewater had to be carried out.

From the trial tests run through the prototype, it is advisable that the column of zeolite is not less than 25 cm as this column depth gave us the optimum percentage removal for most quality in the three trial runs. According to literature review depth of column of 20 cm is commonly used in adsorption columns of previous research so we decided to look at column of 15 cm, 20cm, 25 cm and 25cm gave us the highest percentage removal of quality like BOD, COD, TN, TP, pH, and Turbidity. However, it could be economical to consider the 20cm column depth as well. This is because the results achieved from it were satisfactory and up to the required standard for effluent discharge.

The Zeolites were found to be particularly effective at removing 90.8 % Chemical Oxygen Demand and 81.3% of Biological Oxygen Demand from Biyinzika industry effluent. These were the quality with the highest concentrations and therefore this means that the main objective of the research was achieved.

5.2 RECOMMENDATIONS.

Based on the findings of this project, the following recommendations came up;

Investigate the use of activated carbon and zeolites in treatment of industrial effluent. Activated carbon according to literature reduces Total Nitrogen values in waste water and when combined with zeolites will be able to treat the water to the NEMA discharge standards.

Increase the percentage removal of Total Nitrogen. From the results, the Total Nitrogen percentage removal is 64.2 % and is the lowest for all tested quality. More research should be done into how the percentage removal of Total Nitrogen by the zeolites can be increased.

Investigate the use of pumice in addition to zeolites for pollutants of higher concentrations. Pumice due to its large surface area and high porosity can be used as a filter in waste water treatment. This would increase the industrial effluent treatment efficiency of the zeolite.

By addressing these recommendations, future research can bridge the gap between the promise of zeolite technology and its practical application in industrial wastewater treatment. This will contribute significantly to the development of sustainable and efficient solutions for industrial effluent management.

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APPENDIX

B.E.L

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SYSTEMS UNBS CERTIFIED

TEST REPORT

Certificate Number:	BEL/003/01/2024		
Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIEL		**Sample Receipt Date** 11/01/2024	**Analysis Start Date:** 11/01/2024
Client Address and contact: UGANDA CHRISTIAN UNIVERSITY 0779512919			
Lab Sample ID: A005/2024		**Date of analysis completion** 16/01/2024	**Date of issue of the certificate** 17/01/2024
Client Sample ID: Effluent wastewater from Biyinzika poultry			
Sample type and Location: Wastewater from Biyinzika poultry in Kigunga			
State of the sample on delivery Water in 5 ltr jerycan		**Testing conditions:**	Relative humidity: 70.2% Temperature: 24.8

Parameter(s)	Test Results			
	Units	Wastewater from Biyinzika poultry	Test Method(s) Used	East African standard for portable water EAS 12:2014
pH	-	7.7	APHA 4500-H B	5.0- 8.5
Turbidity	NTU	58.7	HACH DR/890 Method 8237	25
Electrical Conductivity	µs/cm	171.8	ELECTROMETRIC METHOD	1000
Total Nitrogen	mg/l	20.74	HACH DR/890 Method 10072	10
Chemical Oxygen Demamd	mg/l	517	HACH DR/890 Method 8000	70
Biochemical Oxygen Demamd	mg/l	128	BOD-5	50

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.
mg/L- stands for miligrams per liter.
SB- Subcontracted

Tested By:
Quality Analyst
....

BIOCORE ENTERPRISES LIMITED
17 JAN 2024
P.O. BOX 892, KAMPALA
0393 228012
Email: biocorenter@gmail.com

Approved By:
Laboratory Manager
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TEST REPORT

Certificate Number: BEL/009/02/2024		
Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIELL **Client Address and contact:** UGANDA CHRISTIAN UNIVERSITY 0779512919	**Sample Receipt Date** 14/02/2024	**Analysis Start Date:** 14/02/2024
Lab Sample ID: A013/2024, A014/2024, A015/2024 **Client Sample ID:** Effluent wastewate from Biyinzika Poultry **Sample type and Location:** Wastewater from Biyinzika Poultry in Kigunga	**Date of analysis completion** 19/02/2024	**Date of issue of the certificate** 19/02/2024
State of the sample on delivery: Wastewater in 500ml bottles	**Testing conditions:** Relative humidity: 71% Temperature: 25 degrees	

Parameter(s)	Units	Effluent from Biyinzika Poultry – Morning	Noon	Evening	Test Method(s) Used	National Environment Effluent Discharge Standards, 2020
pH	pH units	6.41	6.37	6.38	APHA 4500- H B	5.0-8.5
Chemical Oxygen Demand	mg/l	215	832	885.3	HACH DR/890 Method 8000	70
Biochemical Oxygen Demand	mg/l	38.3	172.3	157.4	BOD-5	50
Total Nitrogen	mg/l	20	10	27.7	HACH DR/890 Method 10072	10
Total phosphorus	mg/l	14.4	66.1	66	HACH DR/890 Method 10127	05
Turbidity	NTU	115.3	90	150	HACH DR/890 Method 8237	25

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.

mg/L- stands for miligrams per liter

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19 FEB 2024
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TEST REPORT

Certificate Number:	BEL/012/02/2024	
Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIELL Client Address and contact: UGANDA CHRISTIAN UNIVERSITY 0779512919	Sample Receipt Date 24/02/2024	Analysis Start Date: 24/02/2024
lab Sample ID: A023/2024, AO24/2024, A025/2024 Client Sample ID: Effluent wastewater from Biyinzika Poultry Sample type and Location: Wastewater from Biyinzika Poultry in Kigunga	Date Of Analysis Completion 28/02/2024	Date Of issue of the Certificate 28/02/2024
State of the sample on delivery: Wastewater in 500ml bottles	Testing conditions:	Relative humidity: 69% Temperature: 24.5 degrees

Parameter(s)	Test Results					
	UNITS	EFFLUENT FROM Biyinzika Poultry			Test Method (S) Used	National Environment Effluent Discharge Standards, 2020
		Morning	Noon	Evening		
pH	-	6.53	6.29	6.44	APHA 4500-H B	5.0 - 8.5
Chemical Oxygen Demand	mg/l	225.2	810	893	HACH DR/890 Method 8000	70
Biochemical Oxygen Demand	mg/l	32.6	180.4	160.8	BOD-5	50
Total Nitrogen	mg/l	23	15	31.8	HACH DR/890 Method 10072	10
Total phosphorus	mg/l	17.6	71.3	70.7	HACH DR/890 Method 10127	05
Turbidity	NTU	124.5	100	144.6	HACH DR/890 Method 8237	25

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.
mg/L stands for miligrams per liter

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B.E.L

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TEST REPORT

Certificate Number: BEL/013/03/2024

Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIELL **Client Address and contact:** UGANDA CHRISTIAN UNIVERSITY 0779512919	**Sample Receipt Date** 26/02/2024	**Analysis Start Date:** 26/02/2024
lab Sample ID: A027/2024, AO28/2024, A029/2024 **Client Sample ID:** Effluent wastewater from Biyinzika Poultry **Sample type and Location:** Wastewater from Biyinzika Poultry in Kigunga	**Date Of Analysis Completion** 01/03/2024	**Date Of issue of the Certificate** 01/03/2024
State of the sample on delivery: Wastewater in 500ml bottles	**Testing conditions:**	Relative humidity: 70.4% Temperature: 26 degrees

Parameter(s)	Test Results					
	UNITS	EFFLUENT FROM Biyinzika Poultry			Test Method (S) Used	National Environment Effluent Discharge Standards, 2020
		Morning	Noon	Evening		
pH	-	6.57	6.38	6.47	APHA 4500-H B	5.0 - 8.5
Chemical Oxygen Demand	mg/l	219	845.3	876	HACH DR/890 Method 8000	70
Biochemical Oxygen Demand	mg/l	35.3	177.8	152.8	BOD-5	50
Total Nitrogen	mg/l	21	13	26	HACH DR/890 Method 10072	10
Total phosphorus	mg/l	20.1	75	77.4	HACH DR/890 Method 10127	05
Turbidity	NTU	107.3	102	153.8	HACH DR/890 Method 8237	25

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.
mg/L stands for miligrams per liter

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ZEOLITE PREPARATION

Ferric Chloride mass = 21.36g

Distilled water mixed with ferric chloride = 1 litre

Zeolite mass mixed = 800g

Distilled water plus ferric chloride mixed with zeolites of sieve size o.15mm to 0.3mm

Stir time = 15 minutes

Settling time = 3 hours

Washed with distilled water and filtered off the water.

SILVER NITRATE TEST.

3 drops of Silver Nitrate.

No observable change.

Chloride ions absent

....

WABBI DANIELL

....

BUSHENDICH JUDAH KWEMOI

....

MR. EDDIE OJARA

LAB TECHNICIAN

B.E.L

BIOCORE LABORATORY

"Environment Conservation Is Our Responsibility"

TEST REPORT

Certificate Number: **BEL/018/03/2024**

Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIELL	**Sample Receipt Date** 14/03/2024	**Analysis Start Date:** 14/03/2024
Client Address and contact: UGANDA CHRISTIAN UNIVERSITY 0779512919		
lab Sample ID: A040/2024, AO41/2024, A042/2024	**Date Of Analysis Completion** 18/03/2024	**Date Of issue of the Certificate** 18/03/2024
Client Sample ID: Treated Effluent using Zeolte		
Sample type and Location: Treated Effluent from Zeolte Treatment Prototype		
State of the sample on delivery: Treated Effluent in 500ml Bottle	**Testing conditions:**	Relative humidity: 68% Temperature: 24.8 degrees

Parameter(s)	Test Results					
	UNITS	DEPTH OF COLUMN(cm)			Test Method (S) Used	National Environment Effluent Discharge Standards, 2020
		15cm	20cm	25cm		
pH	-	6.52	6.36	6.18	APHA 4500-H B	5.0 - 8.5
Chemical Oxgyen Demand	mg/l	156.9	112.4	76	HACH DR/890 Method 8000	70
Biochemical Oxgyen Demand	mg/l	68	44.6	33.1	BOD-5	50
Total Nitrogen	mg/l	8.7	6.2	4.6	HACH DR/890 Method 10072	10
Total phospherus	mg/l	17.6	11.9	6.7	HACH DR/890 Method 10127	05
Turbidity	NTU	60	45	23	HACH DR/890 Method 8237	25

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.
mg/L stands for miligrams per liter

Tested By:
Quality Analyst
....

BIOCORE ENTERPRISES LIMITED
18 MAR 2024

Approved By:
Laboratory Manager
....

This Certificate of analyst is only valid if it becomes authorised signature and an official stamp. It may not be reproduced other than in full, except with the manager the laboratory Manager Biocore Laboratory.

BIOCORE Laboratory, Namanve Industrial Park - Ssempala Road, P.O Box 892, Kampala, Uganda. Tel: 0393 228 012, E-mail:info@biocorenterprises.com

B.E.L

BIOCORE LABORATORY

"Environment Conservation Is Our Responsibility"

TEST REPORT

Certificate Number: BEL/019/03/2024		
Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIELL **Client Address and contact:** UGANDA CHRISTIAN UNIVERSITY 0779512919	**Sample Receipt Date** 14/03/2024	**Analysis Start Date:** 14/03/2024
lab Sample ID: A043/2024, AO44/2024, A045/2024 **Client Sample ID:** Treated Effluent using Zeolte **Sample type and Location:** Treated Effluent from Zeolte Treatment Prototype	**Date Of Analysis Completion** 18/03/2024	**Date Of issue of the Certificate** 18/03/2024
State of the sample on delivery: Treated Effluent in 500ml Bottle	**Testing conditions:** Relative humidity: 68.6% Temperature: 24.7 degrees	

Parameter(s)	Test Results					
	UNITS	DEPTH OF COLUMN			Test Method (S) Used	National Environment Effluent Discharge Standards, 2020
		15cm	20cm	25cm		
pH	-	6.57	6.38	6.22	APHA 4500-H B	5.0 - 8.5
Chemical Oxygen Demand	mg/l	154	111	75.8	HACH DR/890 Method 8000	70
Biochemical Oxygen Demand	mg/l	67.3	49	32	BOD-5	50
Total Nitrogen	mg/l	9.4	6	3.9	HACH DR/890 Method 10072	10
Total phosphorus	mg/l	16.6	11	6.2	HACH DR/890 Method 10127	05
Turbidity	NTU	60	42.8	24.2	HACH DR/890 Method 8237	25

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.

mg/L stands for miligrams per liter

Tested By:
Quality Analyst

BIOCORE ENTERPRISES LIMITED
18 MAR 2024

Approved By:
Laboratory Manager

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B.E.L

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TEST REPORT

Certificate Number: BEL/017/03/2024		
Client Name: BUSHENDICH JUDAH KWEMOI & WABBI DANIELL **Client Address and contact:** UGANDA CHRISTIAN UNIVERSITY 0779512919	**Sample Receipt Date** 14/03/2024	**Analysis Start Date:** 14/03/2024
lab Sample ID: A037/2024, AO38/2024, A039/2024 **Client Sample ID:** Treated Effluent using Zeolte **Sample type and Location:** Treated Effluent from Zeolte Treatment Prototype	**Date Of Analysis Completion** 18/03/2024	**Date Of issue of the Certificate** 18/03/2024
State of the sample on delivery: Treated Effluent in 500ml Bottle	**Testing conditions:** Relative humidity: 68.2% Temperature: 24.5 degrees	

Parameter(s)	Test Results					
	UNITS	DEPTH OF COLUMN			Test Method (S) Used	National Environment Effluent Discharge Standards, 2020
		15cm	20cm	25cm		
pH	-	6.54	6.34	6.20	APHA 4500-H B	5.0 - 8.5
Chemical Oxygen Demand	mg/l	158	114	76.3	HACH DR/890 Method 8000	70
Biochemical Oxygen Demand	mg/l	69.7	48	32.9	BOD-5	50
Total Nitrogen	mg/l	9	6.4	4.4	HACH DR/890 Method 10072	10
Total phosphorus	mg/l	18	11.6	7	HACH DR/890 Method 10127	05
Turbidity	NTU	62	44	25	HACH DR/890 Method 8237	25

REMARKS:

Results do apply only for the sample as it was received and analysed. The client bears sampling responsibility as the representative characters of the sample delivered.
mg/L stands for miligrams per liter

BIOCORE ENTERPRISES LIMITED
18 MAR 2024
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Tested By:
Quality Analyst

Approved By:
Laboratory Manager

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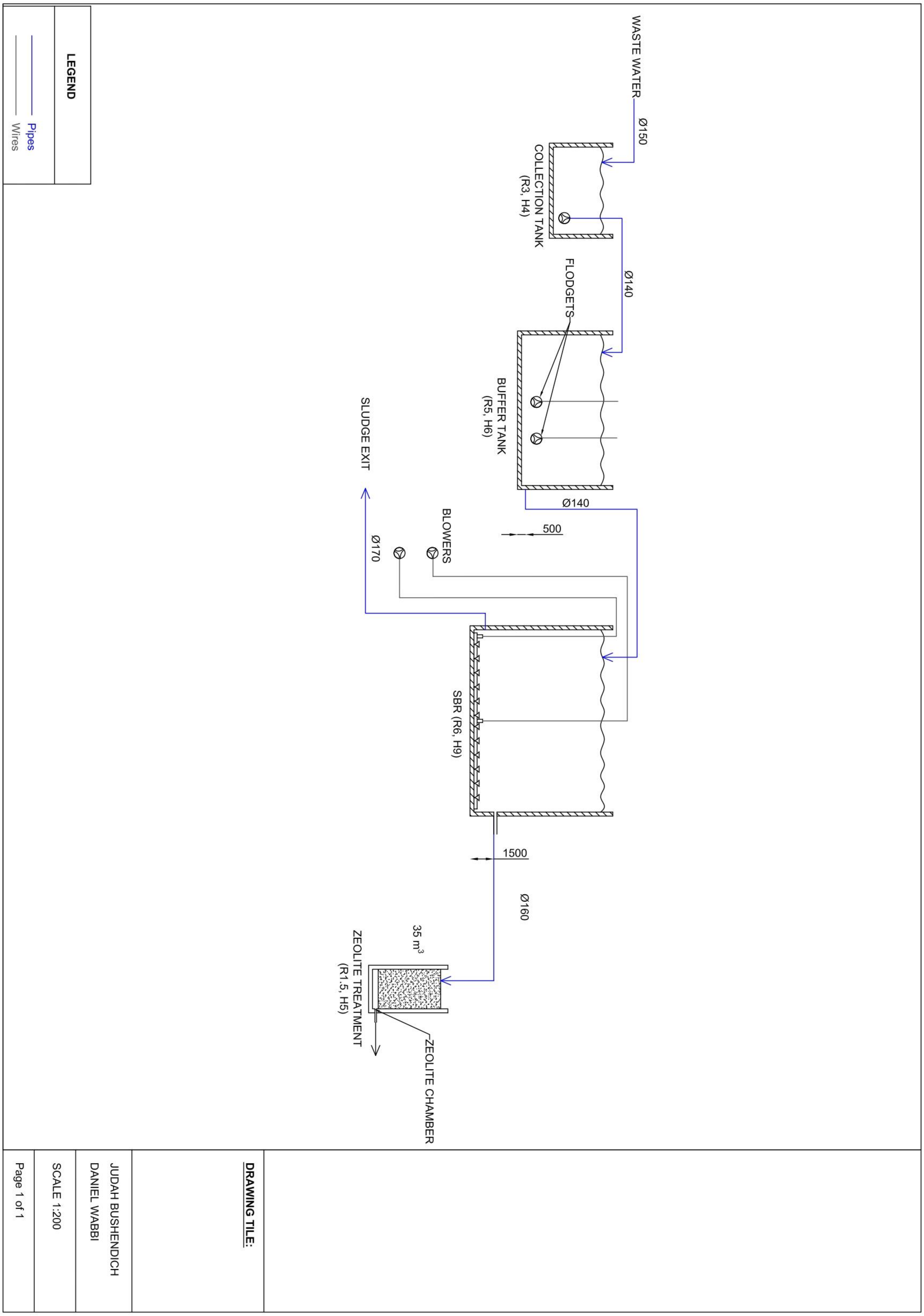
LEGEND
Pipes
Wires
WASTE WATER
Ø150
COLLECTION TANK
(R3, H4)
Ø140
FLODGETS
BUFFER TANK
(R5, H6)
Ø140
500
SLUDGE EXIT
BLOWERS
Ø170
SBR (R6, H9)
1500
Ø160
35 m3
ZEOLITE TREATMENT
(R1.5, H5)
ZEOLITE CHAMBER
DRAWING TILE:
JUDAH BUSHENDICH
DANIEL WABBI
SCALE 1:200
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