COMPARATIVE STUDY BETWEEN INNARE CLAY COMPOSITES AND EMHE CLAY COMPOSITES FOR WATER TREATMENT

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CERTIFICATION

We, the undersigned hereby certify that this research work titled "comparative study between innare clay composite and Emhe clay composite for water treatment" was carried out by **Oriorohwo Blessing Ochuko** with **Matric. No AST/2372071099** in the Department of Physical Science Laboratory Technology, School of Applied Sciences and Technology, Auchi Polytechnic, Auchi, Edo State.

We also certify that the work is adequate in scope and content in partial fulfillment of the requirements for the award of Higher National Diploma (HND) in Physical Science Laboratory Technology (Chemistry/Biochemistry Option)

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DEDICATION

This project is dedicated to God almighty for his undeserved kindness, his unending Love, giving me the breathe of life and protecting me till this very moment which made it possible for me to get to where I am in my educational pursuit.

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Special thanks and sincere gratitude goes to my God Jehovah, the maker of life and the giver of every good thing and every perfect present for all he has done and still doing for me.

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To my uncle and his wife, Mr. and Mrs. Oriorohwo Godwin Oghenedoro and his outstanding children; my Aunty's, Mrs. Modupe Okobe and Mrs. Oyebode Damilola and their exceptional children and My late uncle, Engineer Frederick Sawyer I say thank for all the love and financial assistance. You shall never lack.

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ABSTRACT

One of the 21st century issue is water. Water is needed by all humans, plants, and animals for economic productivity and social wellbeing. The lack of clean water has enormous consequences and affects the general wellbeing of humans and limits economic development. The aim of this research is to utilize two varieties of clay (innare and Emhe clay) mixed with aluminum chips at different ratios in order to determine the combination ratios and equally determine which of the two clay is best suited for the treatment of river water. Eight different ratios were used. The weights (20g) of the clay was kept constant for both clay while the weight of aluminum were varied by 2 (2-14g). The composite were constituted into ten tiny beads and place in each labeled beakers. 500ml of the river water sample was measured into eight separate beakers and left for ten minutes contact period. The composite constituted were used to treat water. Adsorption study was carried out on the river water using pH, SS, COD, EC abd Tds to monitor the treatment rate. The pH, SS, EC and Tds results obtained for the control are 5.1, 0.1, 0.06 and 53 respectively. The pH of innare clay range from 7.0 to 7.8, SS was not detected for this clay composite, EC range from 0.06 to 0.09, tds range from 56 to 70 and COD gave undulating values with the minimum as 736 and the maximum as 3584. While for Emhe clay the pH range form 7.4 to 7.8, SS value shows 0.1 weight difference for 20g clay and 2g allimunium while for others SS was not detected. EC range from 0.07 to 0.08, Tds range from 57 to 60 and the COD values also gave undulating values with the minimum as 1728 and the maximum as 6016. The results revealed that innare clay has high potential of treatment when compared to the Emhe clay composite

CHAPTER ONE

1.1 Introduction

Water, air, food and shelter are the essential items for any living being. It is possible to survive without food and shelter for some days, but without water, it is not possible to survive much of the time. Without air, one cannot live for a few minutes. Next to air is water which is of paramount importance to all organisms (Booker, 2000)

Water help to maintain and sustain human life, animal and plant (Patil and Patil, 2010). The availability of good quality water is an indispensable feature for preventing disease and improving quality of life (Oluduro and Aderiye, 2007). Safe drinking water is a human birthright as much as clean air, however much of the world's population does not have access to safe drinking water.

Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid and polio. Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks. This is particularly the case in health care facilities where both patients and staff are placed at additional risk of infection and disease when water, sanitation and hygiene services are lacking. Globally, 15% of patients develop an infection during a hospital stay, with the proportion much greater in low-income countries.

The fact that 85% of total population of the world has no access to healthy and uncontaminated water is not an overstatement (WHO, 1997; Ahmed et al., 1989). It is well-known that greater part of global population consumes untreated non-piped drinking water usually consisting of small volumes collected and stored in the home by the users (Sobsey *et al;* 2003). In preparation for future emergency, households, organizations, etc. May collect and store drinking water for a long period of time. Drinking water may often be collected from any available source including facially contaminated sources, and stored in a vessel which may not be properly treated. This will no doubt increase the production of disease causing pathogens and hence deteriorate the stored water further (Andrew, 2004; Sobsey, *et al;* 2003, Trevett, 2003, Trevett *et al;* 2001). Studies by U.S. environmental protein agency have shown that potable water stored for over a certain period in clean 55-gallon drums in level defense shelters become contaminated in terms of water quality. Glass container, metal container, plastic container (a synthetic material affected by heat or pressure shaped into a water tight container),calabash (a product of vine grown for its fruit, which when matured and harvested can be dried and used as container) and clay pot (an act of pottery product of weathered soil particles of hydrated aluminum trioxosilicate (iv) and Silicon (iv) oxide) are among the storage vessels used to collect and store water for its various uses (Andrew, 2004, 1990).

In order to properly understand and grasp the concept of water storage and benefit of water stored in storage containers specifically clay pot, one has to understand what water itself is and what it's concept entails.

Water is an inorganic, transparent, tasteless, odorless, and nearly colorless chemical substance, which is the main constituent of Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent. It is vital for all known forms of life, despite providing neither food, energy, nor organic micronutrients.

Water covers about 71% of the Earth's surface, with seas and oceans making up most of the water volume on earth (about 96.5%). Small portions of water occur as groundwater (1.7%), in the glaciers and the ice caps of Antarctica and Greenland (1.7%), and in the air as vapor, clouds (consisting of ice and liquid water suspended in air), and precipitation (0.001%). Water moves continually through the water cycle of evaporation, transpiration (Evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

Water is a chemical substance that is composed of two atoms of hydrogen and an atom of oxygen (Hayward, 2004). In typical usage, water refers to only its liquid form or state, but the substance also has a solid state known as ice, and a gaseous state called steam or water vapor. According to Parsons and Jefferson (2006), water to be consumed by man/animals should fall within the range of certain limits set by World Health Organization (WHO) often known as drinking water standards. Such water that is fit for human consumption is called potable water.

1.2 Statement of Problem

Water is readily available all over the world but only a very few proportion of it is potable or fit for human consumption. Hence, there is the need of storing potable water in containers in order to ensure continuity in supply during interruption or as a result of microbial effect. Such containers used in storing water are called water storage reservoirs or tanks. Storage reservoirs are available in various forms based on the material of construction such as clay, galvanized steel, polyethylene, fiberglass, and concrete. They are also available in various shapes/size of container such as buckets, bottles, pots, GP tanks, over-head tanks, etc. A good storage reservoir should be able to maintain the quality (i.e. physio-chemical and bacteriological properties) of the water. And as such this research focuses on the ability of clay composites to be able to effectively treat water while adhering to WHO's standard for water that is drinkable.

1.3 Aims and Objectives of Study

The main aim of this study is to carry out a comparative study between innare clay composite and Emhe clay composite for water treatment.

The objectives are:

1. To determine the physiochemical parameters value using Omouku River water as the control
2. To determine the physiochemical parameters of the water samples containing composites for both clay types respectively.
3. To compare the results obtained for the control and the water samples.
4. To compare the results obtained for the water sample containing Innare clay composite with that of Emhe clay composite.
5. To determine the physio chemical properties of the water sample gotten from clay soaked in the river water
6. To determine at which composition ratio of either of the clay composite is the water best treated

1.4 Scope of Study

This study was carried out on water sample collected from Omouku River Water in Auchi, Etsako west community, Edo state. The study is centered on ascertaining at which composition of either clay composite is the water best treated using WHO's standard.

CHAPTER TWO

2.1 Literature Review

Water is very essential for life. Water is an invaluable resource to man and living things, essential for the sustenance of life (Al Nahyan 2012) on earth as exemplified by its diversified uses (drinking, cooking, washing, irrigation, farming etc.). The quality of drinking water is a powerful environmental determinant of health (WHO, 2010). Adequate supply of safe drinking water therefore is universally recognized as a basic human need and one of the most essential factors of civilization. Millions of people in developing countries do not have access to adequate and safe water supply. Increasing population and urbanization make it difficult for governments around the world to meet the increasing demand for portable drinking water. In a recent survey by Majuru *et al;* (2011), it is estimated that 65 million Nigerians had no access to safe drinking water.

Safe drinking water is a basic need for good health, and it is also a basic right of humans. Fresh water is already a limiting resource in many parts of the world. In the next century, it will become even more limiting due to increased population, urbanization, and climate change.

Drinking water quality is a relative term that relates the composition of water with effects of natural processes and human activities. Deterioration of drinking water quality arises from introduction of chemical compounds into the water supply system through leaks and cross connection.

Access to safe drinking water and sanitation is a global concern. However, developing countries, like Nigeria, have suffered from a lack of access to safe drinking water from improved sources and to adequate sanitation services (WHO 2006). As a result, people are still dependent on unprotected water sources such as rivers, streams, springs and hand dug wells. Since these sources are open, they are highly susceptible to flood and birds, animals and human contamination.

The quality of water is affected by an increase in anthropogenic activities and any pollution either physical or chemical causes changes to the quality of the receiving water body (Aremu et al; 2011). Chemical contaminants occur in drinking water throughout the world which could possibly threaten human health. In addition, most sources are found near gullies where open field defecation is common and flood-washed wastes affect the quality of water.

The World Health Organization estimated that up to 80 % of all sicknesses and diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water (WHO 1997). A review of 28 studies carried out by the World Bank gives the evidence that incidence of certain water borne, water washed, and water based and water sanitation associated diseases are related to the quality and quantity of water and sanitation available to users (Abebe 1986). Therefore there is need and high demand for water stored in suitable reservoirs for effective water treatment and handling.

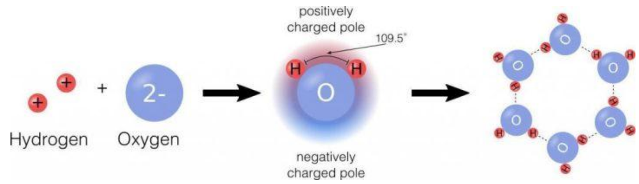
The Chemistry of Water

Water makes up 60-75% of human body weight. A loss of just 4% of total body water leads to dehydration, and a loss of 15% can be fatal. Likewise, a person could survive a month without food but wouldn’t survive 3 days without water. This crucial dependence on water broadly governs all life forms. Clearly water is vital for survival (molly Sargen, 2019).

All life processes involve water. Water is an excellent solvent for many ionic compounds, as well as for other substances capable of forming hydrogen bonds with water.

Water is a simple molecule that has only three atoms, but its unique properties make it the most important molecule in life. This extraordinary importance of water molecule came basically from the arrangement of atoms in the molecule and the bonds involved.

Many of water’s roles in supporting life are due to its molecular structure and a few special properties. Water is a simple molecule composed of two small, positively charged hydrogen atoms and one large negatively charged oxygen atom. When the hydrogens bind to the oxygen, it creates an asymmetrical molecule with positive charge on one side and negative charge on the other side (Figure 1). This charge differential is called polarity and dictates how water interacts with other molecules.



Also, water’s extensive capability to dissolve a variety of molecules has earned it the designation of “universal solvent,” and it is this ability that makes water such an invaluable life-sustaining force. On a biological level, water’s role as a solvent helps cells transport and use substances like oxygen or nutrients. Water-based solutions like blood help carry molecules to the necessary locations. Thus, water’s role as a solvent facilitates the transport of molecules like oxygen for respiration and has a major impact on the ability of drugs to reach their targets in the body (Dan utter & molly Sargen 2019)

Simply put, Its versatility and adaptability help perform important chemical reactions. Its simple molecular structure helps maintain important shapes for cells’ inner components and outer membrane. No other molecule matches water when it comes to unique properties that support life. Excitingly, researchers continue to establish new properties of water such as additional effects of its asymmetrical structure. Scientists have yet to determine the physiological impacts of these properties. It’s amazing how a simple molecule is universally important for organisms with diverse needs. (Dan utter, 2019)

2.2 Source/ Types and Forms of Water

Based on its source, water can be divided into ground water and surface water (Gray, 2017) Surface waters can be simply described as the water that is on the surface of the Earth. This includes the oceans, rivers and streams, lakes, and reservoirs. Surface waters are very important. They constitute approximately 80 percent of the water used on a daily basis(.Nace, 1967)

Groundwater is defined as water that is found beneath the surface of the Earth in conditions of 100 percent saturation (if it is less than 100 percent saturation, then the water is considered soil moisture). Ninety-eight percent of Earth's available fresh water is groundwater. It is about 60 times as plentiful as the fresh water found in lakes and streams.

Groundwater constitutes an important source of water supply for domestic and agriculture purposes in Nigeria. Groundwater is believed to be comparatively much cleaner and free from pollution than surface water. However, prolong discharge of industrial effluents, domestic sewage and solid waste dump causes the ground water to be polluted thereby creating health problems (Raja, 2002).

Water quality parameters

Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose.

Water quality can be classified into four types-potable water, palatable water, contaminated (polluted) water, and infected water (Chatterjee, 2001). The most common scientific definitions of these types of water quality are as follows:

Potable Water: It is safe to drink, pleasant to taste, and usable for domestic purposes (Spellman, 2013)

Palatable Water: It is esthetically pleasing; it considers the presence of chemicals that do not cause a threat to human health (Chatterjee, 2001)

Contaminated (Polluted) Water: It is that water containing unwanted physical, chemical, biological, or radiological substances, and it is unfit for drinking or domestic use (Chatterjee, 2001)

2.3 Parameters of Water Quality

There are three types of water quality parameters physical, chemical, and biological (Gray, 2008)

The physical parameters include color, taste, odor, temperature, turbidity, solids, and electrical conductivity.

On the other hand, chemical parameters can include pH, acidity, alkalinity, chlorine, hardness, dissolved oxygen, and biological oxygen demand. The third type of parameter involves biological parameters, which include bacteria, algae, and viruses.

Physical Parameters of Water Quality

Turbidity

Turbidity is the cloudiness of water (Apha, 2005). It is a measure of the ability of light to pass through water. It is caused by suspended material such as clay, silt, organic material, plankton, and other particulate materials in water (Alley, 2007). Turbidity in drinking water is esthetically unacceptable, which makes the water look unappetizing.

Temperature:

Temperature is not directly used to evaluate whether water is potable (drinkable) or not. In natural water system like lake and river, temperature is very important physical factor that determines water quality. If temperature increase, solubility of Oxygen in water decreases.

Furthermore rise in temperature increases the growth rate of aquatic microorganism, so they consume dissolved O2 faster and level of dissolved O2 decreases

Taste and Odor:

Pure water is always tasteless and odorless. Therefore if any types of taste and odor is present, it indicates water pollution.

Water taste and odor may develops due to natural or artificial regions.

Artificial region for taste and odor in water is due to disinfection process (chlorination). Some natural impurities dissolved in water can also give taste and odor.

Color:

Pure water is colorless. Therefore any type of color appearance in water indicates water pollution.

Natural water system is often colored by foreign material. If color is due to suspended material, it is called as apparent color. Color given by dissolved material that remains even after removal of suspended material is called true color or real color

Electrical conductivity (EC)

The electrical conductivity (EC) of water is a measure of the ability of a solution to carry or conduct an electrical current [Tchobanoglous,2003]. Since the electrical current is carried by ions in solution, the conductivity increases as the concentration [Apha,2005] of ions increases. Therefore, it is one of the main parameters used to determine the suitability of water for irrigation and firefighting.

Solids

Solids occur in water either in solution or in suspension [Tchobanoglous, 2003]. These two types of solids can be identified by using a glass fiber filter that the water sample passes through. By definition, the suspended solids are retained on the top of the filter and the dissolved solids pass through the filter with the water [Apha,2005].

Chemical parameters of Water Quality

pH

pH is one of the most important parameters of water quality. It is defined as the negative logarithm of the hydrogen ion concentration [Spellman,2017]. It is a dimensionless number indicating the strength of an acidic or a basic solution [Hammer, 2011]. Actually, pH of water is a measure of how acidic/basic water is [Tomer, 1999].

Chemical oxygen demand (COD)

The chemical oxygen demand (COD) is a parameter that measures all organics: the biodegradable and the non-biodegradable substances [Tchobanoglous,2003]. It is a chemical test using strong oxidizing chemicals (potassium dichromate), sulfuric acid, and heat, and the result can be available in just 2 h (Apha, 2005).

Hardness

Hardness is a term used to express the properties of highly mineralized waters. The dissolved minerals in water cause problems such as scale deposits in hot water pipes and difficulty in producing lather with soap (Davis, 2010).

Calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions cause the greatest portion of hardness in naturally occurring waters (Spellman, 2017).

2.4 Chemistry of Clay

Clay is a soft, loose, earthy material containing particles with a grain size of less than 4 micrometres (μm). It forms as a result of the weathering and erosion of rocks containing the mineral group feldspar (known as the 'mother of clay') over vast spans of time.

Clay is the oldest known ceramic material. Prehistoric humans discovered the useful properties of clay and used it for making pottery. Some of the earliest pottery shards have been dated to around 14,000 BC,(Scarred, 2005) and clay tablets were the first known writing medium. (Ebert,2011) Clay is used in many modern industrial processes, such as paper making, cement production, and chemical filtering. Between one-half and two-thirds of the world's population live or work in buildings made with clay, often baked into brick, as an essential part of its load-bearing structure.

Clay is a very common substance. Shale, formed largely from clay, is the most common sedimentary rock. (Boggs, 2006) Although many naturally occurring deposits include both silts and clay, clays are distinguished from other fine-grained soils by differences in size and mineralogy. Silts, which are fine-grained soils that do not include clay minerals, tend to have larger particle sizes than clays. Mixtures of sand, silt and less than 40% clay are called loam. Soils high in swelling clays (expansive clay), which are clay minerals that readily expand in volume when they absorb water, are a major challenge in civil engineering. (Olive *et al;* 1989)

Clays develop plasticity when wet, due to a molecular film of water surrounding the clay particles, but become hard, brittle and non–plastic upon drying or firing.Most pure clay minerals are white or light-coloured, but natural clays show a variety of colours from impurities, such as a reddish or brownish colour.

Clays are divided into two classes:

Residual clay: Residual clays are found in the place of origin and formed by surface weathering which give rise to clay in three ways:

- ✓ Chemical decomposition of rocks, such as granite, containing silica and aluminia
- ✓ Solution of rocks, such as limestone, containing clayey impurities, which, being insoluble, are deposited as clay
- ✓ Disintegration and solution of shale (Kerr, 1952).

Transported clay, also known as sedimentary clay, removed from the place of origin by erosion and deposited in a new and possibly distant position.

2.5 Clay Minerals

Clay minerals are the characteristics minerals on the earth found near planetary surface (the surface where the outer crust of the object comes in contact with atmosphere) environment with variable amount of ions like iron, magnesium, alkali metals, alkaline earth metals and other cations. They are considered as important constituents of soil and form by diagenetic and hydrothermal alteration of rocks in presence of water (Tong, 2020). They are commonly found in fine grained sedimentary rocks such as shale, mudstone and siltstone. Clay minerals act as "chemical sponges" as they have capacity to hold water and dissolved plant nutrients eroded from other minerals due to the presence of some unbalanced electrical charge on their surface (Kerr, 1952). As water is essential for clay minerals formation, therefore, most of the clay minerals are known as hydrous alumino silicate or hydrous aluminum phyllosilicate.

The properties that define the composition of clay minerals are derived from chemical compounds present in clay minerals, symmetrical arrangement of atoms and ions and the forces that bind them together. The clay minerals are mainly known as the complex silicates of various ions such as aluminum, magnesium and iron (Benjamin, 2020). On the basis of the arrangement of these ions, basic crystalline units of the clay minerals are of two types:

Silicon – oxygen tetrahedron consists of silicon surrounding by four oxygen atoms and unite to form the silica sheet.

Aluminum or magnesium octahedron consists of aluminum surrounding by six hydroxyl units and combine to form gibbsite sheet (If aluminum is main dominating atom) or brucite sheet (If magnesium is main dominating atom) (Guggenheim, 2003).

CHAPTER THREE22

3.1 Materials and methods

3.1.1 Aluminium material

- Aluminum chips

3.1.2 Water Sample

- Omouku river water

3.1.3 Clay Sample

- Innare clay and Emhe clay types

3.1.4 Apparatus

- Volumetric flasks
- Conical flask
- Dessicator
- Oven
- Measuring cylinder
- Wash bottle
- Reflux condenser
- Spatula
- Tissue paper
- pH meter
- Conductivity meter
- Tds meter

- Mortar and pestle
- 600mc size sieve pan
- Analytical weighing balance
- Glass funnels
- Beakers
- Reagent bottle
- Filter paper
- Round bottom flask
- Cotton wool
- Pipette
- Retort stand
- Heating mantle

3.1.5 Reagents

- Potassium dichromate
- Sulphuric acid (conc)
- Ferrous ammonium sulfate
- Silver sulphate
- Mercury sulphate
- Ferroin indicator
- Distilled water
- Potassium chloride

- Buffer 4
- Buffer 7
- Silica gel

3.2 Methods

3.2.1 Collecting and Gathering if Aluminum Chips

Pulverized aluminum particules were collected from nearby aluminum bar workshop within the Auchi environs specifically secretariat area in Auchi, behind UBA Bank, Auchi, Edo state.

3.2.2 Collection and Handling of Water Sample

The water sample was obtained by grab sampling method from Omouku River in Auchi, Etsako west community in Edo state using a neat 10 litres keg.

3.2.3 Collection of Clay Sample

The clay samples were obtained by grab sampling method from Imiegba community in Etsako west, Local Government Area, Edo state. Two types of clay named innare clay and Emhe clay was collected.

3.2.4 Formation of Clay Composite

The process of formation of clay composite starts at the point when the clay and aluminium was transported down to the laboratory from the place of collection respectively.

Firstly, the aluminum chips were filtered using 600mc size of filter/sieve so as to get smaller particles. Then the clay (both clay types) was pounded separately using a laboratory size mortar and pestle so as to get it in powder form.

After this has been done, the process of formation of pebbles follows. The pebbles were formed by the combination of clay and aluminium in different grams (weight) through the addition of a minimum amount of water. Ten pebbles were formed for each weight and this process was carried out and repeated for both clay types respectively.

Next is the drying of the pebbles (clay composites) fir 2hours in the oven at 105 °©.

3.2.5 Comparative process of Preparation and Analyzing Water Sample

- **Determination of pH**

500ml of the water sample (raw sample) was measured and used to soak the two different types of clay composite respectively. This was allowed to stay for 10minutes. After this it was filtered using a filter paper and then 100ml of the just filtered water sample was measured into a 500ml conical flask. A previously calibrated pH electrode (calibrated using buffer 4 and buffer 7) was then placed in the beaker containing the sample and the reading was taken.

This process was repeated for all the samples containing the dissolved clay composites for both clay types and after each step the electrode was removed from the sample, properly rinsed with distilled water and gently wiped clean with tissue paper.

- **Determination of Total Dissolved Solid**

Just as the case with determination of pH, the water was also measured and used to soak the two different types of clay composites respectively, after which a filter paper was then used to filter the water into another conical flask.

Then 100ml of the sample was measured using a 500ml measuring cylinder into a 500ml conical flask. A previously cleaned and well handled Tds electrode (cleaned with a tds cleaning solution) was then placed in the beaker containing the sample as the reading was recorded after a stable value was obtained. The electrode was removed from the sample and rinsed with distilled water and wiped gently. This process was repeated for all 16samples containing the two different clay composite respectively.

- **Determination of Electrical Conductivity**

The same procedure was also utilized as in the case with pH determination and tds determination except that in this case a conductivity meter was used.

To do this 100ml of the water sample to be analyzed was poured into a 500ml beaker and a conductivity electrode was dipped into it to determine the electrical conductivity of the water.

The reading was taken at a stable point of value and this step was repeated again for all samples to be analyzed.

- **Determination of Suspended Solid**

The suspended solid was determined by the process of weight change determination. Here a filter paper was first dried in the oven for 30minutes at 105°© and then placed in a dessicator (containing silica gel) to ensure cooling. After cooled for 10minutes in the dessicator, the weight of the filter paper was then taken using an analytical weighing balance (This process was repeated twice so as to check and ensure constant weight of the filter paper).

After the above process, 100ml of the already prepared water sample was then measured and filtered into a volumetric flask. This was done by placing a funnel above the volumetric flask after which a well folded filter paper which was previously dried on it. The water was filtered into the volumetric flask through passage of the previously weighed filter paper.

Next, the wet filter paper was then taken back to the oven and dried at 105°© for 15minutes, cooled in the dessicator for 10minutes and then reweighed. The observed weight as displayed on the analytical weighing balance was thereby recorded. This process was repeated for all samples respectively/ accordingly.

- **Determination of COD**

COD stands for Chemical oxygen demand and the process involved in analysis using this parameter is divided into three categories, which are: the preparation of Reagents, Heating of the sample and then titration.

- **Preparation of Reagents**

The first step here is the preparation of the digestion solution which is the standard potassium dichromate reagent. To prepare this, 4.913g of potassium dichromate which has dried at 103°© for two hours in the oven was weighed and transferred into a beaker. After this 33.3g of mercuric sulphate was then weighed and added to the same beaker containing the potassium dichromate (4.913g) which was previously weighed. Then also 167ml of concentrated sulphuric acid was measured using a clean dry 500ml measuring cylinder and then transferred into the same beaker. The contents of of the mixture present in the beaker was then dissolved and allowed to cook overnight so as to ensure it is properly dissolved. Then the next day, 100ml standard volumetric flask was taken with a funnel placed on it in order to transfer the content of the beaker into it after which it was then made up to 1000ml mark using distilled water.

Next is the preparation of the catalyst solution eis the sulphuric acid reagent. To do this, 5.5g of silver sulphate crystals was weighed into a clean dry 1000ml beaker. Then 500ml of concentrated sulphuric acid (conc $H2SO4$) was carefully added into the same beaker containing the previously weighed silver sulphate crystals and allowed to stay for 24hours so as to ensure proper dissolvation.

Lastly for the preparation of Reagents is the preparation of standard ferrous ammonium sulfate which was prepared by weighing 39.2g of ferrous ammonium sulfate crystals using an analytical weighing balance. After weighing it was poured into a 500ml beaker and dissolved with distilled water. Then, the content of the beaker was transferred into a 1000ml volumetric flask and made up to the 1000ml mark if the flask.

- **Heating of the sample**

After the reagents have been properly prepared following all protocol and adhering to the temperature and time requirements, the next step is to heat each of the water samples.

To do this, 2.5ml of the sample was added to a round bottom flask along with 1.5ml potassium dichromate reagent and 3.5ml of sulphuric acid reagent all together in the round bottom flask. The round bottom flask was then placed on a heating mantle set to a temperature of 150°© for 2hours. The set up has a reflux condenser placed on the flask to avoid evaporation and this condenser contains opening where pipes are connected to help with the passage of water within the inlet and outlet. This is to help with cooling as heating is taking place and then the socket is turned on for heating to begin. This process was carried out accordingly for all water samples following the just explained procedure.

- **Titration of the Heated Sample**

This is the prices that comes next after the sample has been heated. After heating the sample for 2hours at 150°©, the content of the round bottom flask was first allowed to cool to room temperature as the socket has been turned off. After cooling has been ensured fir the sample present in the flask, it is then transferred into a beaker for titration. A previously fixed burette attached to a retort stand was then used. Ferrous ammonium sulfate (standard) solution was poured into the burette to make it up to the zero mark, as few drop if ferroin indicator was adeede to the sample content present in the beaker. At the point of adding ferroin indicator a colour change of bluish green was observed. Then titration begins as few drops of ferrous ammonium sulfate react with the content of the beaker okaved omunder it with constant swirling. The endpoint of the each titration was then taken at the point where the content of the beaker changes color from the previously light orange colour at the start of titration to reddish brown colour subsequently.

The aforementioned processes and steps were carried out for distilled water (blank), control (raw river water), water sample containing Innare and Emhe clay composite respectively.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

Table 4.1: Result of physiochemical analysis of water quality parameters of omouku river water for comparative study of the water sample containing dissolved clay and aluminium mixtures (clay composite) for innare clay and Emhe clay types respectively

Table 4.1.1: Table for Composition and Results of Physiochemical Parameters Value for Innare Clay Composite

Parameters	Control (raw River Water)	0	1	2	3	4	5	6	7	Standard (WHO)
Clay (g) Innare clay		20	20	20	20	20	20	20	20	
Al chips (g)		0	2	4	6	8	10	12	14	
Composite total mass (g)		20	22	24	26	28	30	32	34	
Vol. Of water (ml)surface	500	500	500	500	500	500	500	500	500	
pH	5.1	7.0	6.6	6.5	6.7	7.2	7.4	7.5	7.8	6.5-6.8
Tds	53	56	57	55	70	54	63	68	59	50-150
Ss	0.1	0	0	0	0	0	0	0	0	Imp free
Conductivity (Ec)	0.06	0.07	0.07	0.07	0.07	0.06	0.09	0.09	0.09	<1ms/cm
COD		1568	3296	3584	2272	2816	3006	736	2016	The lower the better

Table 4.1.2: 2 Table for Composition and Results of Physiochemical Parameters value for Emhe clay Composite.

Parameters	Control (raw River Water)	0	1	2	3	4	5	6	7	Standard (WHO)
Clay (g) Emhe clay		20	20	20	20	20	20	20	20	
Al chips (g)		0	2	4	6	8	10	12	14	
Composite total mass (g)		20	22	24	26	28	30	32	34	
Vol of surface water (ml)	500	500	500	500	500	500	500	509	500	
pH	5.1	7.6	7.6	7.6	7.6	7.8	7.6	7.4	7.5	6.5-6.8
Tds	53	57	60	58	59	58	59	60	62	50-150
SS	0.1	0	0.1	0	0	0	0	0	0	Imp free
Conductivity (EC)	0.06	0.07	0.08	0.07	0.08	0.07	0.07	0.07	0.08	<1ms/cm
COD										The lower the better

4.2 Discussion of Result

The comparison between innare clay composite and Emhe clay composite for water treatment was observed and properly analyzed. This comparison was carried out using five different physiochemical parameters. For some the water treatment was carried on pure clay type soaked in water and then filtered to constitute a water sample while for others it was done for the clay composites i.e those containing both clay and aluminium combined.

The physiochemical parameters used to ascertain at which combination or which of the clay / clay composite best treats the water includes pH, SS (suspended solid), COD (chemical oxygen demand), EC (Electrical conductivity) and Tds (total dissolved solid) and the values obtained in each case for the two clay types are shown in Table 4.1.1 and 4.1.2 above.

pH is an important parameter in evaluating the acid - base balance of water. It is also the indicator of acidic or alkaline condition of water status. According to WHO's recommendation the maximum permissible limit of pH is from 6.5 to 8.5. The current research and investigation range shows the pH values obtained for the water samples for each clay composite in the table above.

A pH range of 6.5 to 7.8 was obtained for alm 16samples. However, the raw water sample (control) from the omouku river water has a pH of 5.1.

From this observation and results stated, it was shown that while comparing the pH of the control with those of the water samples containing the clay composites, the latter best treats the water as their pH falls within the range if safe drinking water according to WHO's recommendation. However, the pH value obtained for the former shows that the water is more acidic and as such indicating the significance of the clay composites as efficient means for water treatment regardless of their weight.

Total dissolved solid (Tds) in water are some organic and inorganic materials which includes minerals and ions that are dissolved in a particular quantity in water. High levels of Tds can affect the taste of drinking water, lead to health hazards, affect eater filtration system, alter the taste of food, leaves ugly spot on utensils fand can also cause scale to form in pipes and appliances.

According to WHO, water rgat has a Tds level more that 1000mg/l is unfit for consumption and as such the palatability quotent for a wekk treated water has acceptable Tds values ranging: 50 - 150 is excellent, 150 - 300 is fair, 300 - 500 is poor while above 1200 is unacceptable. Following this, it was shown during this experiment that the TDS values obtained for both clay composite water samples and the control all fall within the 50 - 150 range for a water that is excellent for drinking. For the water sample Tds value from 55 to 68ppm (mg/l) was obtained while that if the control was 53, all within who's standard for water thatvis drinkable.

The conductivity values of the water samples for borg clay types are shown in the tables above. Conductivity itself is the measure of the dissolved ionic component in water and hebce electrical characteristics. Electrical conductivity gives an indication of the amount of total dissolvation substitution in water. Values recorded for EC of the control is 0.06 ms/cm while those of the water samples consisting of clay composites ranges from 0.07 to 0.09 with the EC of the raw water (control) been the least of the values and at increased aluminum content the highest value was obtained.

From the recorded conductivity values, the observation shows that even with increasing allimunium content on the clay, the water sample still gave closely related values for EC which is between 0.06 - 0.09 Ms/cm and according to WHO standard for a well treated and drinkable water, the electrical conductivity should be less than 1ms/cm thereby indicating that both the control and water samples with clay composite are safe for drinking.

Suspended solids is the most common measure of the amounts of solid, both organic and inorganic, in waste water effluent. Raw river water has SS value of 0.7 and 0.8 before and after filtration respectively thereby indicating the present of impurities and particles present in the water. However, after going through primary treatment via the different clay composite, the values shows total absence of impurities for innare clay type as no weight change was observed before and after filtration and presence of impurity for one sample our of the right samples analyzed for the Emhe clay composite. Comparing the value for innare clay composite with that of the control and Emhe clay composite, it was shown that the inare clay best treats the water as no impurity was observed for all samples analyzed.

The chemical oxygen demand (COD) is a measure of water and wastewater quality. The COD test is often used to monitor water treatment. The test is based on the fact that a strong oxidizing agent under acidic conditions can fully oxidize almost any organic compound to carbon dioxide. When the COD levels are higher, there is a greater demand for oxygen. Therefore, the lower the COD the better.

For innare clay composite, the calculated COD values obtained for each of the 8samples are 1568, 3296, 3584, 2272, 2816, 3006, 736 and 2016 respectively. However for the Emhe clay composite higher values of 2364, 1728, 4768, 3680, 2272, 4992, 6016 and 5152 were obtained respectively. This therefore indicate that the lowest COD values was obtained from innare clay composite containing 20g of clay and 12g allimunium chip, thereby showing that the water is best treated with innare clay at increased aluminum content.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the comparative study carried out between innare clay composite and Emhe clay composites shows different values each step and process of treatment as indicated by the physiochemical parameter range.

The result shows that innare clay composite has high potential of treatment when compared to the Emhe clay composite.

5.2 Recommendation

Based on the findings, research, investigations and values obtained from the physiochemical parameters used to analyze the water samples for effective water treatment, it is recommended that;

1. To avoid drinking contaminated water, proper water storage containers like clay pot should be used.
2. From this study, clay isire suitable source of adsorption and means of treatment of water and as such the general public should be informed of its positive effect and importance on the system especially considering the fact that it contains no carcinogenic substances.
3. Clay with increased aluminum content has also been shown to have positive influence on the water and also to help increase the water treatment methods and as such further studies should be carried out to helo emphasize this key point.

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