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Control of Water Borne-Diseases: Fabrication of Movable Water Treatment Plant Using Natural Ingredients

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ABSTRACT
In the region and elsewhere in the world, accessibility to a constant supply of pipe-borne water is difficult for some of the population, especially those living in rural areas. This project describes the design, fabrication and testing of a portable water treatment plant. It was design using very cheap materials with no need for a conventional power sources. The untreated water is placed into the tank. The water then flows through the system by means of gravity passing through a simple locally made filter of sands layers and gravel. After filtration, the effluent is then passed through the tank B chamber which contain the Activated charcoal and then passes through the micro-filter into the tank C located at the base. The device was tested using one type of untreated water which is river water. The treated water was chemically tested to determine the quality and the effectiveness of the device. The result where compared favorably with the World Health Organization standard for drinking water. This portable device would ensure that portable water is both economically and easily available to other regions, particularly in rural areas.

Keywords:*water treatment, river water, portable, natural ingredients, rural areas.*

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I. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Water is one of the most important resources on earth because it sustains life. Water forms on integral part of the structural composition of cells and is an essential component of diet (Baloch et al. 2000).Access to safe drinking water and sanitation is important in terms of health especially for children and old persons. Unsafe drinking water contributes to numerous health problems including socio-psychological effects in developing countries (Mark *et al*, 2002;Lamidi, 2012). Water is a combination of hydrogen and oxygen atoms with a chemical formula H_2O and known to be the most abundant compound (70%) on earth surface (Osei,2005). Water demand exceed supply in many part of the world. As of 2004 1.1 billion people lacked access to improved water sources, (Egirami, *et al*, 2004) water is essential for both life and livelihood.

New water treatment facilities have helped to provide safe drinking water. Nevertheless pollution from agricultural source and dissolve organic carbon are issues in some communities. Drinking water supply in numbers of these communities could be unhealthy and not meeting regulatory standard. Rural dwellers in the Niger delta have tried over the years to develop efficient method for purifying water from dirty swamps but these method have fallen short of standard. Fabrication would be an answer to the problem of unhealthy drinking water. Purification of dirty water using this method is cheap, portable and available for homes in rural communities. It would need no electric power to run it. It would be treated using natural ingredients. Water is a universal solvent because it is capable of dissolving other substances more than any other known solvent .water is useful to man in many ways: for example it is used for generating electricity, also used in cooking, bathing, swimming, washing etc. The source of water include; wells, groundwater, boreholes and springs that are properly located produce water of a good quality. Lack of accessibility to portable water supply poor environmental sanitation contributes to numerous health problem including socio-psychologically effect in developing countries (Lamidi, 2012).

1.2 STATEMENT OF PROBLEM

Portable water should be suitable for drinking, cooking etc. it should be odourless, colourless, and tasteless, it should contain no harmful biological organism and it should be neutral in terms of acidic and alkaline content.But in the rural areas the accessible water in contaminated with impurities such as dangerous micro-organism, oil spills and sewages. (Lamidi, *et al, 2019*).

This project is therefore concerned with the design and fabrication of cheap, simple and readily available system for getting pure water from the large body of impure water through water treatment using natural ingredients.

Water serves as major constituent to human body for physiological and chemical processes and thus essential for health and life. Its availability and consumption is vital for man's survival and sustainability (sobey, 2002).

According to WHO (2004) improved drinking water sources should be constructed and design to protect the water source from outside contamination.

Nigeria is one of the many Africans countries facing problems of accessibility to clean drinking water. Although it is reported that 27 million Nigerian have gained access to clean drinking water since 1990 (NPC, 2006), only 47% of the population can access safe water.

1.3 AIM AND OBJECTIVES

AIM:- To design and fabricate movable water treatment plant using natural ingredients.

Objectives:

I To construct a simple tank for biological purification of water using natural ingredients.
II To fabricate a simple sand bed filter tank for physical purification.
III To construct a simple tank for chemical purification of water using natural ingredient.
IV To get pure and fresh water using natural ingredient.

1.4 JUSTIFICATION OF THE PROJECT

Water is essential for health; the World Health Organization (WHO, 2014) estimates the water related diseases are responsible for 5.8% of all deaths and 5.5% of all disability adjusted life years. This include the four billion cases of diarrhea that occur throughout the world each year**,** and the resultant 2.2billion deaths. It also include those caused by other water related disease like typhoid fever. These diseases, result not only from ingestion of pathogens contained in poor quality water, but also due to inadequate water supply for personal and domestic hygiene practice, which resulted into people looking for water from any source without treatment before drinking. The project can be adopted for the fabrication of water treatment for the use in the local communities.

1.5 SCOPE AND LIMITATION OF THE PROJECT

The project is restricted to the design and fabrication of portable, cheap and reliable, movable water treatment for domestic use around the environment. The fabricated movable water treatment is to produce pure and clean water using natural ingredient.

II. LITERATURE REVIEW

Distillation has long been considered a way of making water drinkable and purifying water in remote locations. As early as the fourth century B.C, Aristotle described a method to evaporate impure water and then condense it for portable water. Arabian chemists were the earliest known people to use solar distillation to produce portable water in the sixteen century. However, the first documental reference for a device was made in 1742 by NicoloGlezz. Of Italy, although it is not known whether he went beyond the conceptual stage and actually build it.

2.1 WATER

Water is absolutely essential for life, it is undoubtedly the most important natural resource that exists in our planet (Abowei and George, 2009). The quality of water available and accessible to a community has tremendous impact on their living standard and well-being.

Thus global and local effects and widespread at ensuring adequate provision of clean and safe water to the world's growing populations. Although water plays an essential role in supporting human life and biodiversity, (Abowei and George, 2009),

Water is a clear liquid having the chemical formular H_2O, required by all forms of life on Earth, As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms. Water is a liquid at standard ambient temperature and pressure, but often it coexists on Earth with the solid state, ice and gaseous state.

2.2 TYPES OF WATER

a **Hardwater** – this is saturated with calcium, iron, magnesium and many other inorganic minerals, water in lakes, rivers on the ground, in the deep wells is classified as hard water. Many city – systems take water from rivers or lakes or reservoirs supplied with mountain water; they erroneously call their supplied "soft water" but it is soft onlyin comparison with water which is harder.

b**.** **Boiled water** – boiling help remove some of the germs, but concentrates the inorganic minerals. Other germs are carried into the fertile element for rapid and lusty propagation of germs and viruses already in the body.

c**.** **Raw water**- this has not been boiled. Raw water may be hard (Calcium hardened water) or soft as raw water. It contains millions of germs and viruses. In every drop, one of these viruses and bacteria may adversely affect the thyroids glands, the liver and other vital body organ.

d**.** **Rain water**-this has been condensed from the cloud. The first water is distilled water. But when it falls as rain, it picks up germs, dust, smoke, minerals, lead and many other atmospheric chemicals by the rain water reaches the earth it is so saturated with dust and pollutants, it may be yellowish in color.

e**.** **Snow water**- this is frozen rain. Freezing does not eliminate any germ. All snowflakes have hardened mineral deposits. Melt the cleanest snow and you will find it saturated with dirt, inorganic minerals, germs and viruses.

f**.** **Filtered water**- this water has pass through a fine strainer, called a filter. Some calcium and other solid substances are kept in the filter. There is no filter made which can prevent germs from passing through the fine meshes. Each pure of the finest filter is large enough for a million viruses to seep through in a few moment.

g. **Soft water**- this water is soft in comparison with water which is harder. It contains many trace of minerals and chemicals, viruses and bacteria. It is not to be confuse with "Softened water". Soft water may be classified as water which is harder than distilled water.

2.3 PORTABLE WATER

Portable water, also known as drinking water or improved drinking water, is water safe enough for drinking and food preparation. This is water that has been filtered, cleaned or treated to meet the standards for drinking, meaning that it is reasonably clear of contaminants and harmful bacteria.

Globally, in 2012, 89% of people had access to water suitable for drinking. Nearly 4 billion had access to tap water while another 2.3 billion had access to wells or public taps 1.8 billion people still use an unsafe drinking source which may be contaminated by faeces. This can result in infection diarrhea such as cholera and typhoid among others (WHO/UNICE, 2014).

In Nigeria, only few of the water purification methods are currently being used, with water disinfection being the most widely used.

Sand bed filtered- this is a kind of depth filter broadly use in separating particles solid from fluid (. E.g water) it works by providing the particulate solid with many opportunities to be captured in the surface of a sand gram. It can be captured by using several mechanism such as direct collision, surface change alteration (Huisan, 1974).

Activated charcoal filter-otherwise known as carbon filter is used to remove contaminant and impurities using a bed of activated carbon. Typical particle size that can be remove by carbon filter ranges from 0.5 – 50 um. It is based upon the flow rate regulation that is when water is allowed to flow through the filter at a slow rate the contaminants are exposed to the filter media (pope, 2013).

Coagulation with *Moringa* seeds- Accordingto Ellert(1978), the seeds of *Moringaoleifera* contains significant quantities of low molecular – weight (water soluble proteins) which carries positive change when the crushed seeds are added to raw water, the proteins produce positive charges acting like magnets and attracting the predominantly negatively charged particles (such as clay, silt bacteria and other toxic particle in water). The flocculation process occurs when the protein bind the negative charges forming flocs through the aggregation of particle which are present in water. These flocs are then easily removed by setting or filtration, a situation that gave rise to this study on *Moringa*seed application.

2.4 THE FILTRATION SYSTEM

Natural filtering

1.Percolation : slow movement of water through the pores in soil, permeable rock and other natural filters that filter the water.

2.Filter: porous substance that allows liquid to pass through but catches or retains small particles, filtering the liquid.

3.Filtration is a process in which solid particle are separated from either a gas or a liquid. Filtration is often called "Dead End Filtration" because the suspended particles end up in the filter.

Drinking water quality standard describes parameters set for drinking water. Drinking water must be wholesome, and this is defined in law of standards for a wide range of substances, organisms and properties of water in regulations. The standards are set to be prospective of public health and the definition of wholesome reflects the important of ensuring that water quality is acceptable to consumers. (Guardian of Drinking water Quality, 2016). The standards set by WHO for healthy drinking is that drinking water has to be:

a. Filtered
b. Cleaned
c. Treated

2.5 SOUCES OF WATER

a. Ground water

Ground water forms an integral part of the hydrological cycle. It is source of water for boreholes, wells and springs that feed stream, rivers and lakes. Ground water is important water source in both the urban and rural areas of Nigeria but in the cities, pipe borne water, borehole by individuals are also available (Adekunle*et al 2007*). Majority of the rural populace in Nigeria do not have access to portable water and therefore, depend on well, stream and river water for domestic use (Shittu *et al 2008*).
Although groundwater are under threat from pollution due to human life style manifested by the low level of hygiene, it is not as affected as surface water (Lamidi; *et al 2019*).

b. Surface water

This is water that collects on the ground or in a stream, river, lake, reservoir, or oceans. Surface water is constantly replenished through precipitation and lost through evaporation and seepage into ground water supplied. According to Environmental Protection Agency (EPA. 2007). 68% of community water system users received their water from a surface water system users received their water from a surface water source, such as the later (United State Geological Survey (USGS).

cRain Water

Rain water is a life – giving resource, and without it, there will be no life on Earth. Its primary purpose is to give us water to drink. During a downpour, rain seep into the ground to become part of rivers and lakes, or what is called ground water. Rain water is slightly acidic and very low in dissolved minerals; as such, it is relatively aggressive. Rain water can dissolve heavy metals and other impurities from materials of the catchment and storage tank.

2.6 WATER POLLUTION

Water pollution means such contamination of water or alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent of any other liquid, gaseous or solid substances into water as many likely to create a nuisance or render such water harmful or injurious to public health or safety or to domestic commercial, agricultural orother legitimate uses, or to the life and health of animals or plants or aquatic organisms. (Purohit and Agrawal, 2011).

The sources of water pollution and pollutants include domestic in the discharge of sewage, waste, industrial in the discharge of industrial waste and effluents and agricultural source in the discharge of agricultural wastes, agrochemicals.etc.

If raw sewage is dumped into the soil, the liquids percolates into the ground and this will cause pollution of ground water. Soil acts as filter, but the dissolved toxic substances percolates down, especially the heavy metals (Purohit and Agrewal, 2011).

At least 60 percent of the population is still dependent on underground sources of drinking water, especially in outer city area and distant villages. This very important sources of water is now threatened with pollution from refuse dumps, septic tanks farm yard manure and with diverse agricultural, chemical or biological pollutants.

Some signs of polluted water include the following bad taste of drinking water, offensive odors, unchecked growth of aquatic weeds in water bodies, decrease in number of fish in fresh water and seawater e.t.c (Purohit and Agrawal 2011).

The widespread practice of dumping raw sewage in shallow pits has caused apprehension of ground water pollution in many cities. It attributes in the rise of cholera, hepatitis, dysentery and other water – borne disease to the pollution of ground water especially in the zones where the water table is high as it has been witnessed in some part of Nigeria, Taraba State and Bali Local Government in collusive. (Imohiosen and Elijah, 2014).

2.7 CLASSIFICATION OF WATER POLLUTANTS

The various types of water pollutants can be classified in the following major categories:

1. **Organic pollutants**;

a. **Oxygen Demanding waste**: the waste waters such as domestic and municipal sewage, water from food processing industries, canning industries, paper and pulp mills, breweries etc. have considerable concentration

of biodegradable organic compounds either in suspended colloidal or dissolved form. These waste undergo decomposition and degradation by bacteria activity. Thus, the dissolved oxygen available in the water body will be consumed for aerobic oxidation of organic matter present in the wastewater.

b**. Synthetic Organic Compound**: this include synthetic pesticides, synthetic detergents, food additives, pharmaceuticals, insecticides, plastics and volatile organic (VOCs). Most of these are toxic and bore factoryorganics i.e., they are resistance to microbial degradation. Concentration of some of these in traces make water unfit for different uses.

c**. Oil**: It is a complex mixture of hydrocarbons and degradable under bacteria action. Oil enters into water through oil spills, leak from oil pipes and wastewater from production and refineries.

2**. Pathogens;**

The pathogenic microorganisms enter into water through sewage discharge as a major source or through wastewater from industries. Viruses and bacteria can cause water borne disease, such as cholera, typhoid, polio and infectious hepatitis in human.

3**. Inorganic Pollutants**:

Apart from the organic matter discharged in the water body through sewage and industrial waste, high concentration of heavy metals and organic pollutants contaminate the water. These compounds are non – biodegradable and persist in the environment. These pollutants include mineral acids, inorganic salt, trace element, metals, metallic compound, cyanides, sulphates etc.

2.8 WATER PURIFICATION

Water purification is the removal of contaminants from raw water to produce drinking water that is pure enough for human consumption or for industrial use. Substances, that are removed during the process include parasite (such as *Giardiia*) bacteria, algae, fungi, mineral. (Including toxic metal such as lead, copper etc).

Many contaminant can be dangerous but depending on the quality standard, other are removed to improve the water smell, taste and appearance.

Many environment and cost consideration affect the location and design of water purification plants. Physical chemical purification by use of filtration, sedimentation, alum and boiling. Biological purification by boiling and modern ultraviolet radiation.

2.9 DISCUSSION ON *E-COLI*

Escherichia coli are the predominant member of the facultative anaerobic portion of the human colonic, normal florci. The bacterium only natural habitat is the large intestine of warm blooded animals and since*E- coli*, with some exceptions, generally does not survive well outsides of the intestinal tract its presence in environmental samples, food, or water usually indicates recent faecal contamination or poor sanitation practices in food processing facilities. The population of *E- coli* in these samples is influenced by the extent of faecel pollution, lack of hygienic practices, and storage conditions. The mere presence of *E.coli* in water or food does not indicate directly that pathogenic micro-organisms are in the sample, but it does indicate that there is a heightened risk of the presence of other faecal- borne, bacteria and viruses, many of which, such as salmonella Spp. or hepatitis A virus, are pathogenic. For this reason, *E.coli* is widely used as an indicator organism to identify food and water sample that may contain unacceptable level of fecal contamination.

E.coli is considered a more specific indicator of fecal contamination than fecal coliforms since the more general test for fecal coliforms also detects thermo-tolerant non-fecal coliform bacterial.

2.10 TOTAL PLATE COUNT

The total plate count is the enumeration of aerobic, mesophilic organisms that grow in aerobic conditions under moderate temperatures of 20-45oC. The count includes all pathogens and non-pathogens and is used to determine the hygienic status of food produced. Total plate count can be made using plate count agar. This plate count will tell you how good your sanitization plan is, measure the safety of your product or water supply. This test is the most common test done in factories. It is measured in CFU or colony forming units based on the premise that one bacteria which is invisible to the naked eye will grow to form a cluster or colony which then becomes visible, when in contact with appropriate nutrients and temperature and it is properly spread out.

III. MATERIALS AND METHODS

3.1 MATERIALS

* Water sample from river

* Sand layers
* Filter
* PVC pipe
* Plastic bucket with tap
* Activated charcoal
* Micro filter
* Auto clave
* Nutrient agar
* Hypo and Salt
* Incubator

3.2 METHOD

3.2.1 CONSTRUCTION OF TANK

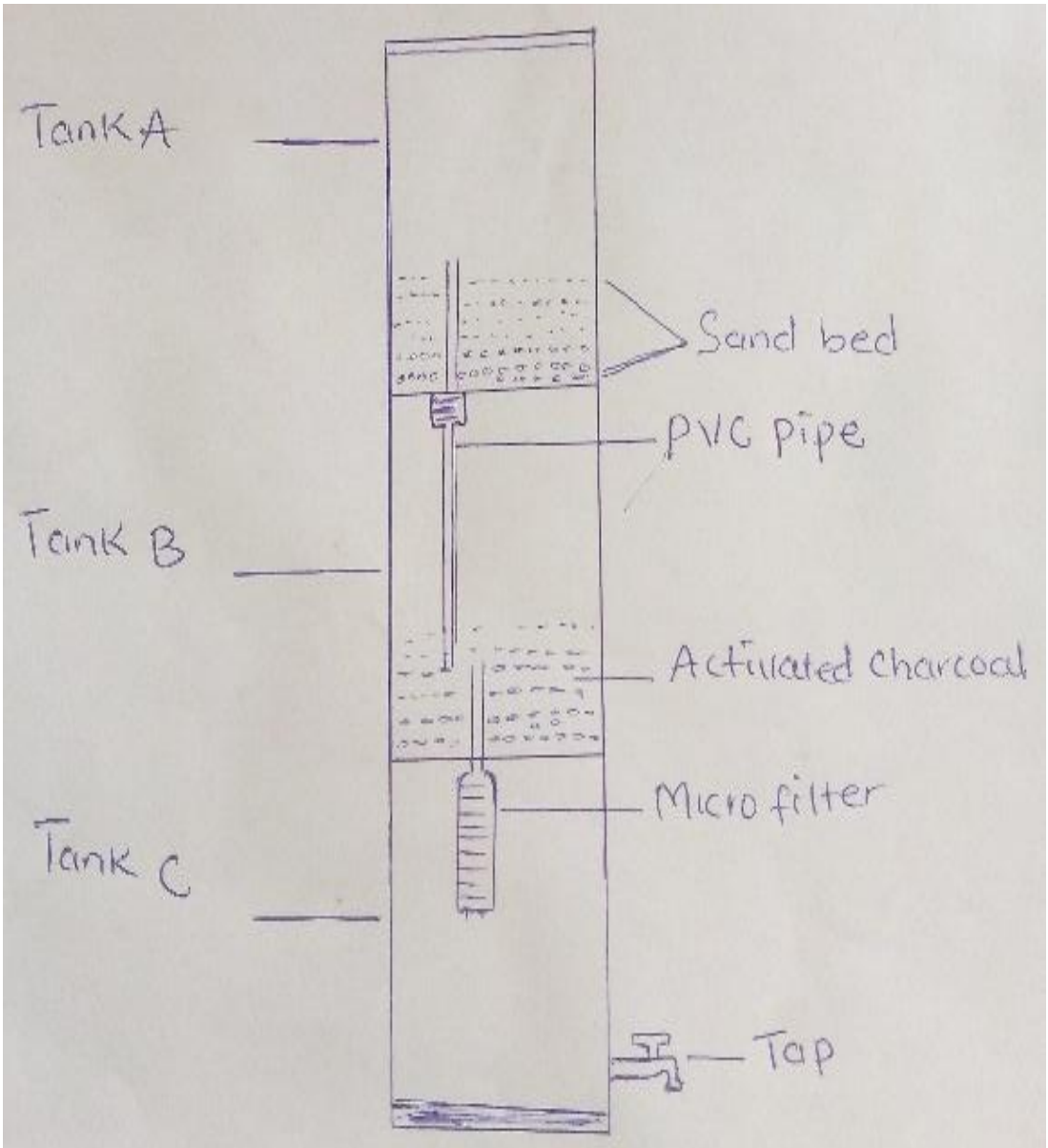

Figure 1

Figure 1. Shows the constructed portable water treatment plant, with three layers of horizontal frames. Tank A, tank B, and tank C layers has the same size. The layers of the tanks are all plastic bucket. Firstly, there is a PVC pipe which connect tank A to the tank B which water pass through. Then there is a micro filter attached inside the tank C which the water passes through. After that a tap was inserted through an open hole in the bottom layer / tank C.

3.3 PRINCIPLE OF OPERATION

This design operates on the process of flow where water is directly added from source e.g. river water. The first tank A is filled with 3 different sand layers with different diameter the sand, gravel. Secondly the activated charcoal, gravel which is inside the tank B. firstly the water passes through the 4 different layers of the sand and proceed the tank B through the PCV pipe. The tank B chamber which react with the water as it passes over it. After that it goes through the tank C which contains the micro filter, and then stored in the bottom of the tank C. After that the treated water is ready. The system was flushed with chlorine to disinfect possible cross contamination in the sand bed and was finally flushed with sterile H_20 before test.

3.4 PREPARATION OF NUTRIENT AGAR

2.8g of nutrient agar power was suspend in 100mls distilled water. The mixture was heated while stirring to fully dissolve all components. The dissolved was autoclave at 121 degrees Celsius for 15 minutes. After the nutrient agar has been autoclaved, it was allowed to cool but not solidify.

3.5 SERIAL DILLUTION

Fivefold dilution was done 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5}. 10mls of the raw water was poured into the sterile test tube. Which serve as the stock, 9ml of sterile water to make 10^{-1} ml was taken from 10^{-1} tube and added to the next tube to make 10^{-2} and repeated until 10^{-5} was achieved. The same procedure was repeated for the finished water.

3.6 INOCULATION

10^{-3} and 10^{-5} were inoculated for both raw water and finished water using pour plate technique. The plates were incubated at 37^{o}C for 24 hours and the number of colonies were counted using counting machine.

IV. RESULT AND DISCUSSION

4.1RESULT

Table 4.1; show results of pretest and posttest of the water sample.

SAMPLECOLONY FROM PER UNIT (CFU)	
Pre-test 10^{-3}	TNTC
Pre-test 10^{-5}	TNTC
Post-test 10^{-3}	15
Post-test 10^{-5}	1

4.2 DISCUSSION

Water is very essential to life and one of the indices of development is access to clean water. The problem of getting portable water has been a major issues since the inception of man. It tends to be even worse for those living in riverine villages near the sea, where ocean water merges with fresh water to form brackish water.

The above investigation of the bacteriological quality of the surface water which serves as drinking water to some people in the rural community and small riverine area like Bali Taraba state is far below standard and is in line with the previous study of Lamidi*et al* (2013)

To solve the challenging problem, this project was designed to address how water can be purified using very cheap fabricated system.

From the result above it implies that the treatment plant was able to reduce the bacterial load to an acceptable number for water portability as given by WHO- that is less than 100cfu/100ml is fit for consumption (WHO, 1994)

V. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The following have been realized in this work from this study, it was concluded, that water sample from Polluted Sources can be purified at least physically and biologically through fabricated movable water purification plant using natural materials. This can go a long way in the control of water –borne diseases.

5.2 RECOMMENDATIONS

With the problem of getting portable water on the increase as water pollution increases with geometric progression in recent years accompanied by outbreak of water-borne diseases like typhoid fever, cholera etc, it is strongly recommended that

1. Federal Government, NGOs and International Organization rendering aids to developing countries, should critically look into this design modify it where necessary mass- produce it with the sole intent of distributing the machines that is movable in rural dwellers, who since the discovery of crude oil have suffered for want of portable water.
2. Once this is achieved, health – related issues associated with polluted water will be eradicated and life will be good for those in the rural riverine areas and communities who have been abandoned since the discovery of the most revered Black Gold. The design is recommended to locations that do not have available or reliable portable water.
3. More work should be done on this prototype and movable treatment plant for more efficacy in the primary and secondary water treatment in our communities.

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