STM JOURNALS

Journal of
Petroleum Engineering & Technology

https://journals.stmjournals.com/jopet

ISSN: 2231-1785 (Online)
ISSN: 2321-5178 (Print)
Volume 14, Issue 2, 2024
May–August
DOI (Journal): 10.37591/JoPET

Research JoPET

An Overview of Examination of Some Basic Raw Materials for Adsorbent on Approach of Pollutant Mitigation and Treatment

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Abstract

This research showcases the basic parameters that are required to produce bio-adsorbent suitable for adsorption process and their important role on treatment of contaminated water environment. The overview of the physicochemical parameters of the raw materials used for the production of the adsorbents, the particle size and the mix ratio were identified as a contributing factor to the rate of contaminants mitigation in the system. The effect of water pollution was considered in term of health implication, environmental impact resulting from radioactive substance, sewage, agriculture, industrial waste, oil pollution, and domestic waste. Method of treatment by the application of boom, manual, skimmer, sorbent, natural, dispersant, burning and bioremediation demonstrates the significance of the novel contribution of these concepts enhanced the examination of the process as well as the outcomes of the research. The investigation demonstrates the usefulness of carrying out experimental concepts and the required laboratories apparatus to measure each of the sample in accordance to the factorial design of the process. The conceptual investigation of the system in terms of process design will be checked to ascertain the performance of the adsorbent as well as the effectiveness of the adsorbent. The performance of the adsorbent can be linked to the characteristics of the formulated samples as well as the physicochemical properties, particle size and the mix ratio.

Keywords: Overview, examination, materials, adsorbent, approach, pollutant

INTRODUCTION

In order to properly understand the subject matter under investigation by this research "Adsorption of Petroleum Based Products Using Plantain, Banana Stems & Clay Mixture in Remediation of Polluted Water Environment", it may be necessary to understand the nature of water, its pollution and why it is necessary to clean up or remediate water bodies. This review will also look at the various methods that has been used for remediation and examine their advantages, the drawbacks and the gaps that needs to be filled in order to justify this particular study. It will also examine recent advances similar to the subject [1-2].

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Received Date: August 14, 2024
Accepted Date: August 23, 2024
Published Date: September 06, 2024

Citation: Ukpaka Chukwuemeka Peter, Nnadi Vincent Gilbert. An Overview of Examination of Some Basic Raw Materials for Adsorbent on Approach of Pollutant Mitigation and Treatment. Journal of Petroleum Engineering & Technology. 2024; 14(2): 1–16p.

WATER

Water is a free gift of nature. It is estimated that 71 % of the earth surface is covered with water. Water occurs in the oceans which holds over 96% of water, in the air as water vapour, in the ground as underground water, in the lakes, rivers, ice caps, glaciers, aquifers etc. Water itself is a chemical compound consisting of two atoms of hydrogen in combination with one atom of oxygen represented as H_2O. It is liquid at standard temperature and pressure and also exists in the gaseous form. It is normally colourless and odourless [3].

Water Pollution

Water pollution may be regarded as the contamination of the various sources of water mention above (Oceans, Rivers, Seas, Lakes, Underground, Gaseous etc) resulting in the change of its physical, chemical or biological properties [4]. This contamination renders it unsuitable for its various uses also mentioned earlier.

Sources of Water Pollution

Water pollution could come from several sources including the following [5-7]:

- *Sewage (Waste Water):* Water from domestic and industrial processes are classified as waste water. When these sources enter recipient water bodies, they change their chemical and biological composition thereby constituting a source of pollution.
- *Agriculture:* Agriculture is a predominant human activity. These activities generate pollutants from fertilizers, pesticides, manure, slurries, animal dumps etc. All these affect water qualities.
- *Radioactive Substances:* Radioactive substances used in nuclear power plants, medical and other industrial processes. Nuclear substances could also be found in electronic parts, watches, televisions, x-ray machines. These are very important sources of water pollution.
- *Dumping:* Dumping of wastes also constitute a major source of pollution. Dumping of plastics, paper, aluminium, food, glass, rubber etc are major concern for water bodies.
- *Industrial Wastes:* Industries are sources of wastes containing toxic chemicals which eventually find their way to water bodies. Also, the burning of fossil fuels constitutes air pollution which leads to acid rains which flows through rivers, streams into the oceans constituting a major source of pollution.
- *Oil Pollution:* The world today depends on oil and its products as a major source of energy. Their exploration, exploitation, transport, processing, storage, usage, sabotages and accidents finally dumps these products and by-products into water bodies thereby constituting another major source of pollution [8].

Effects of Water Pollution

On Health

According to some statistics, water pollution caused the death of 1.8 million people in the planet in 2015. That means that water pollution kills people and makes many others ill. Drinking contaminated water are major causes of illnesses. Diseases such as cholera and typhoid are mainly due to drinking of contaminated water. Heavy metals such as lead, arsenic and mercury are major causes of cancer [9].

On Environment

The ecosystem depends on a complex interaction between plants, animals, fishes, bacteria, fungi. A disruption of these chains is sometimes very catastrophic. This is effectively what water pollution causes. Water pollution causes an algal bloom in lakes and marine environment [10]. These algae population reduces oxygen levels in water which in turn suffocates plants and animals in the marine system. Chemicals and heavy metals contaminate waste water. These contaminants are very toxic to aquatic life in reducing life spans and ability to reproduce. These marine lives eventually make their way into the human food chain with dare consequences. Having examined the nature of water, its various uses, water pollution and sources, the effect of water pollution on humans and the environment [11]. I have established a case for the prevention of water pollution and where not possible its clean-up.

With the consequences of water pollution discussed above, there is therefore no doubt why a huge energy is deployed in the clean-up of polluted water including researches to improve existing methods or finding cheaper methods of doing this which is one of the objectives of this research. I will now try to review all the various methods that has been used in time for clean-up and remediation of petroleum polluted water.

Techniques of oil Spill Clean-up

Before discussing the various techniques used in the clean-up of polluted water resulting from petroleum-based products spillage on water bodies, it may be necessary to define what constitutes an oil spill [12]. Oil spill is a release of liquid petroleum into the environment due mainly to human activity. Nigeria being a major petroleum producing nation encounters frequent oil spillage that constitute pollution of water bodies especially in the Niger Delta region [13]. Some major oil spills recorded in the Niger delta includes the following:

- Spillage of over 570,000 barrels of crude into the Forcados estuary in July, 1979.
- Spillage of about 421,000 barrels from Funiwa well in January, 1980

It is estimated that an average of 240,000 barrels of crude are spilled in the Niger Delta every year. This figure must be conservative if we consider the latest trends of illegal bunkering of petroleum and its products in the region.

With this constituting a major problem to people and environment, a huge effort must be deployed to clean-up polluted water bodies in the region at huge costs. It is estimated that heavy oils costs about $15,000/ton while light fractions may cost about $3,500/ton to clean.

The technique deployed for clean-up depends on wide range of factors including the type of oil, the quantity spilled, the location of spillage, environmental factors, the availability of facilities and of course the cost. The research will now review the various methods used for clean-up of polluted water by petroleum products.

Manual Method

This is the oldest form of clean-up and the most commonly used. It involves a lot of manual labour using teams of workers with tools such as buckets, rakes, shovels, drums. The collected oil is transferred to a processing station or stored in reservoirs and tanks. Hoses and pumps may be used to recover the spilled oil [12-13]. Before a manual method could be applied, it may be necessary to contain the spill in an area. This containment prevents the spill from spreading to a particular area. It could also be used to divert the spill where recovery is possible. While manual recovery may be cheap, it is however labour intensive. A second disadvantage is in its efficiency of recovery. This process may only succeed in the recovery of visible oil leaving a lot of films unrecoverable.

Use of Booms

A boom is a floating barrier used to contain spills on marine environment. It includes a containment partition that floats and extends above the water surface and a curtain that sinks into the water to prevent oil escaping underneath. It is supported at several points by tensioned ropes or steel cables. Boom are usually about 15 to 30m long. To ensure buoyancy, floats are located at several points. The floats are usually made of polyurethane or polyethylene materials. Booms could self-inflating or inflatable from an external source [9].

Sorbent booms are specialized containment and recovery booms equipped with other materials such as polypropylene which absorbs the oil while it is being contained. They are mainly used when the oil slick is thin. There are other special purpose-built booms designed for specific conditions. While booms have served as good containment and recovery equipment, its use may be limited by the weather and other extraneous factors [11].

Use of Skimmers

Oils Skimmers are mechanical devices that are designed to remove oil from water for purposes of recovery or remediation. Skimmers are classified according to the area of use (onshore or offshore) or sometimes by the viscosity of the oil to be skimmed (heavy or light) or according to the operating principle (disk, brush, weir) [10].

The effectiveness of a skimmer is rated according to the quantity of oil it recovers as well as the amount of water in the recovered oil. This effectiveness however depends on such factors as the quantity of spill, viscosity of the oil, thickness of the slick, sea conditions including waves and ambient temperature. Most skimmers function well when the quantity of spill is great. They are therefore deployed downstream of booms. They are sometimes fitted with screens to prevent debris [10]. Skimmers are also classified according to operating principles to include oleophilic, weir, suction, vacuum, submersible, vortex or centrifugal skimmers. Oleophilic skimmers are equipped withs surfaces that are made of fabric, steel, plastics such as polyurethane or polyvinylchloride. These surfaces provide some adhesion to oil making it very effective. A wiper blade wipes off the oil and transfers to a container from where it could be pumped as recovered oil.

While skimmers are largely in use for recovery of oil on polluted water environment, their use are still limited by environmental factors, thickness of oil, presence of debris. Again, its efficiency in terms of oil-in-water recovered is also limited. Though a lot of work has been done and is still being done to improve the observed limitations [11[.

Use of Sorbents

Sorbents are products that recover petroleum products through absorption or adsorption. They are mostly used in the recovery of final traces of spills especially in confined spaces where booms or skimmers cannot be deployed. Sorbents could be classified as natural or synthetic. Natural sorbents could be either organic such as wood products or inorganic materials such as clay. Sorbents could be used in various ways including cleaning of surfaces, wiping of booms after a clean-up operation. They could be used and re-used by simply squeezing out the absorbed oil. The capacity of sorbents depends on the exposed surface area to which oil can adhere and also on the type of surface. To improve performance, some sorbents are treated with oleophilic (oil attracting) and hydrophobic (water repelling) to improve its ability to segregate clean-up of oil instead of water [12].

The performance of sorbents is measured in terms of the weight of the total oil recovered compared to its original weight. Synthetic sorbents are much more efficient. They could recover up to 30 times its original weight compared to inorganic sorbents that could handle only thrice its weight. While the use of sorbents has proved to be very efficient in the circumstances in which they have been deployed, its main disadvantage remains in the regeneration process. The transfer of loaded sorbents from sites to regeneration could result in other spills [13].

Natural Methods

Natural actions of the Sun, Weather and Wave could promote the breakdown oil spilled on water surfaces. If oil spill does not threaten wild life or close to populations, the tendency is usually to leave it and let natural actions take care of the spill especially if the quantity spilled is small. Lighter oils will disperse faster than heavier oils. When oil breaks down as a result of natural actions, they mix with water, sand and other particles to form tar balls. Tar balls eventually scatter over the coastal surfaces. They are seen not as a serious danger to the environment. The disadvantage of this process is that the weathered oil may create secondary films on water surfaces that may require further clean-up through other processes [14].

Use of Dispersants

Dispersants are chemicals that are sprayed on oil spill surfaces to cause a breakdown of the oil into smaller droplets. Dispersants contains certain surfactants chemicals that contain both water and oil compatible ends. At a certain concentration of mixtures, the surfactant molecules attach to the oil and reduce the interfacial tension between oil and water. This reduction allows oil droplets to break off from the slick and minimizes the tendency to re-coalesce. The use of dispersants over the years has been discouraged due to high toxic effects observed when degreasers were applied to the “Torry Canyon oil spill”. This was one of the world’s most serious oil spills when the super tanker ran aground and spilled

over 160 million litres of crude oil off the south west coast of the United Kingdom in 1967. The impacts to communities were very extensive. Though research has produced dispersants with less toxic effects its use as a means of oil spill clean-up is highly regulated and, in some cases, actually banned [11].

Burning

Controlled (in-situ) burning refers to the burning of oil slick at sea or close to site. Controlled burning burns off the oil in water thereby reducing the quantity of oil-in-water. This system is only possible under low windy conditions. There is a limited use of this pr. ocess due to the problems and issues generated by it including the air pollution from heavy smoke and respiratory problems it could cause, formation of extremely viscous and dense residue which sinks at sea and of course the safety concerns from this method [6].

Bioremediation

Bioremediation in oil spill clean-up refers to the addition of materials to contaminated environments to cause an acceleration of the biodegradation process. It is becoming a promising method of oil spill clean-up with little impact to the habitat. The process uses decomposers or their enzymes to improve the condition of the contaminated environment. For example, Bacteria can be used introduced to remove specific contaminants such as hydrocarbon present in crude oil and its products [15, 16].

There are several types of Bioremediations which includes the following;

- Addition of native microbes to increase populations
- Encouraging the growth of native microbes by adding substrates/nutrients which creates a favourable environment for hydrocarbon organisms to degrade toxic compounds present in oil. This is also known as Bio stimulation.
- Addition of microbes that are not native to the environment. This is also known as Bioaugmentation.

Bioremediation has the advantage of utilizing natural processes with minimal equipment, its main drawback includes being a very sensitive process with respect to toxicity and environmental conditions of temperature and pH.

MATERIALS AND METHODS

- *Samples:* Six different samples are required for this research as follows: Water, Clay, Plantain Stem, Banana Stem, Diesel and Petrol
- *Water Sample:* The water samples were collected from water bodies in areas where illegal refining activities were prominent in the Niger Delta as follows:

River Nun Creek in Bayelsa State – Nigeria

River Nun – Source: Google Maps

The river Nun in present day Bayelsa State of Nigeria flows directly from the river Niger. It flows through fresh water and mangrove swamps and finally empties into the Atlantic Ocean at Akassa in Bayelsa State. Figure 1.

It was a major source of trade between indigenous people and Europeans in the 19th Century. The advent of oil business would change the activities around this river. The trans Niger oil pipeline and other flowlines crisscross this river making it a source for the illegal refining activities in recent times. This River was therefore of interest for this research as samples from it will provide a good study for its clean up or remediation when polluted. Figure 2-6.

50 litres of water samples were collected from this river on the 29th September, 2021 as shown below: Figure 3

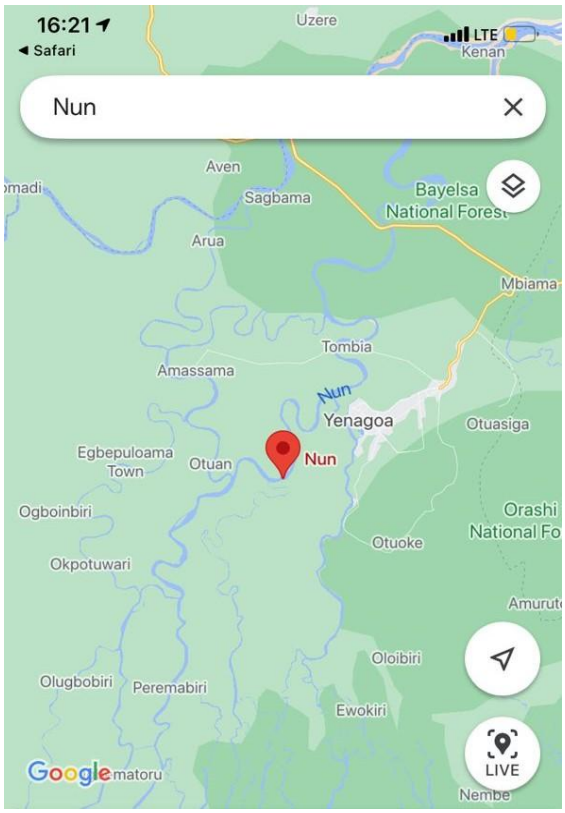

Figure 1. Map of River Nun Creek in Bayelsa State – Nigeria [10].

Figure 2. Illegal Refining Activity along the Banks of the River Nun.

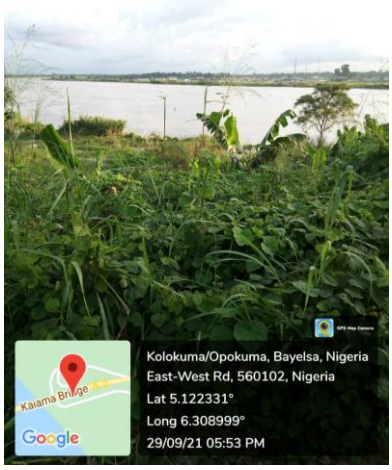

Figure 3. Green Vegetation without Pollution.

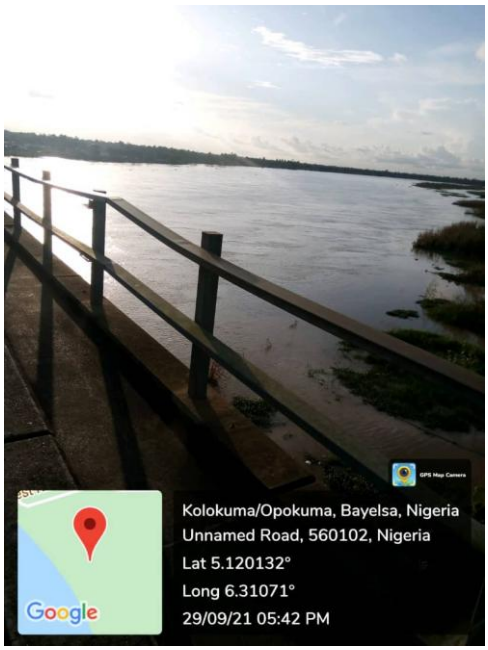

Figure 4. Bodo Creek in Ogoni, Rivers State – Nigeria.

Figure 5. Activities in Sea.

Clay

Clay is a type of soil which are deposits created from rocks due to physical, chemical and biological processes. The physical process results from weathering which causes the disintegration of the rock while the chemical process is responsible for the decomposition of the rock through oxidation, reduction and hydrolysis. The soil formed could be transported to other locations. This is typically the history of Niger Delta soils. Clay is a very dominant type of soil in the Niger Delta. Clay is an earthly material that is plastic when moist and hard when fired. It is composed mainly of hydrous aluminium silicate and other minerals. It is formed from sedimentary activity. Clay possesses the following characteristics:

1. They are sticky when wet
2. They could absorb and hold more water than most other soils
3. The volume could increase when wet and shrink when dried.

The above characteristics lend clay to become a good agent for adsorption and its studies.

The clay for this study was obtained from Oboburu community in Ogba/Egbema/Ndoni Local Government of Rivers State. Due to the abundance of this soil, the community is noted for its product of pottery. Figure 7-10.

The clay is predominantly located in swamps around this community

Figure 6. Water Samples from different Rivers with the Niger Delta.

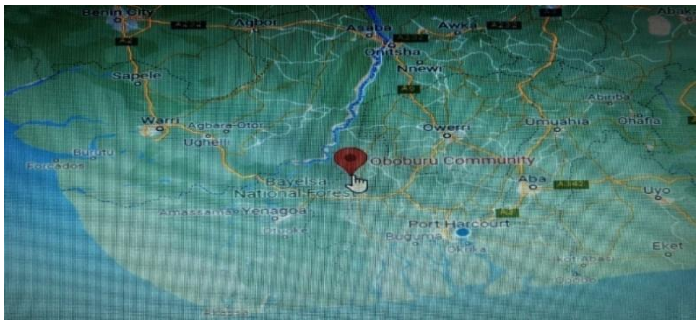

Figure 7. The location of Clay Sample Examined.

Figure 8. Oboburu Swamp.

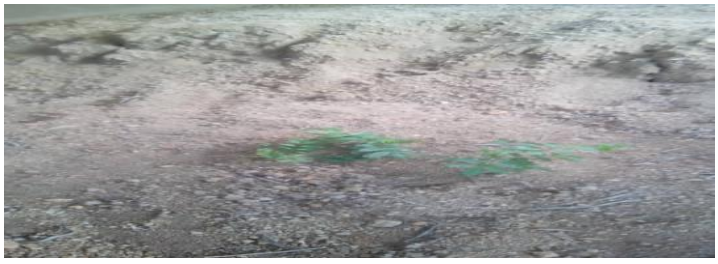

Figure 9. Clay Deposit at Oboburu.

Plantain and Banana Stem

Plantain *(Musa Paradisiaca*) and Banana (*Musa Coccinea*) are tropical edible fruits which abounds in the Niger Delta of Nigeria. They are eaten cooked, boiled, fried or dried. They are known to possess many health benefits. Plantain and Banana stems are mainly made of cellulose fibres. This is the interesting part to this research.

Cellulose fibres have good reactivity and adsorption properties. This work will explore these potentials in a mixture with clay to study the remediation of water polluted with Diesel and Petrol. For the purpose of this study, the samples of Plantain and Banana stems were obtained from their plantations at the Rivers State Agricultural Program (ADP) farm located in Okoro-Odo in Obio/Akpor local Government of Rivers State. This program was established in 1988 to formulate and implement agricultural development programs part of which includes the development of nurseries, varieties and species to support farmers for improved production in agriculture. For the purpose of this study, two varieties each of Banana & Plantain were chosen as follows: Banana – Native Variety, Banana – Ogoni Red Variety, Plantain – Agbagba 1 Variety and Plantain – Ogoni Red Variety. Figure 11-17.

5meters each of the stalk were taken to the Chemical/Petro-Chemical laboratory of the Rivers State University where they were sliced to 2mm and left at room temperature for 5hours. This is to enable the samples loss its moisture content to at least 0.1%.

Figure 10. Some of the Clay Soil Sample Collected.

Figure 11. Life Plantain Stem.

Figure 12. Plantain Stem of Different Species.

Figure 13. Life Banana.

Figure 14. Three species of the Plantain and Banana stems were obtained from the ADP farm.

Figure 15. Manuel Approach of Plantain and Banana Stem Size Reduction.

Figure 16. Manuel Approach of Plantain and Banana Stem Drying at Room Temperature.

Figure 17. Fine Particles of Banana and Plantain of Different Sizes.

The dried chips were thereafter crushed in a fine crusher. The crushed particles were packed into airtight plastic containers in the laboratory.

The Banana and Plantain samples were sieved into three particle sizes of 300microns, 600microns and 1.18mm

Diesel and Petrol

Diesel and Petrol are two kinds of fuel obtained from the fractional distillation of crude petroleum. They are used as fuel for engines. They are pollutants when discharged to water bodies. In Nigeria, Diesel and Petrol are produced in the refineries and distributed to various depots through pipelines. These pipelines are sometimes sabotaged causing large spillages into water bodies causing pollution with its attendant problems. This research is looking into methods of remediation of polluted water using local material of clay, plantain and banana mixtures. For the purpose of this study, Petrol & Diesel samples were obtained from the TotalEnergies Service Station located at Trans Amadi, Port-Harcourt, Rivers State.

Laboratory Equipment

Other laboratory equipment that will be required for the experimental work includes Measuring cylinders, Thermometers, Weighing Balance, Beakers, pH meter, Plastic containers, Oven Dryers, Retort stand & clamps, stop watch, Hand gloves, Goggles, Safety wears

Parameters

The following parameters of the various samples shall be determined using various methods: Density, Concentration, pH, Salinity, Porosity, Particle size distribution, Moisture content**.** Oil-in-Water, Turbidity, Total Hardness, Total Dissolved Solids, Conductivity, Nitrates**,** Dissolved Oxygen, Phosphates, Temperature and Total Hydrocarbon Content

Description of Methods

After assembling the samples, materials and laboratory equipment. Standard methods shall be applied to determine the necessary parameters for the experiment including the physicochemical characteristics of plantain and banana stems, clay.

Physico-chemical Analyses of Water Samples

It is important to determine the physico-chemical characteristics of the various samples that are being used in the adsorption experiment. This is so because some of the parameters my one way or the other influence the adsorption process. For the water samples, the following parameters and methods were used for the analysis.

RESULTS AND DISCUSSION

Basic raw material characteristics and properties of each system considered in this research are presented in Table 1 to 7. The value of parameters tested were compared with the recommended International Standard and some of the values were below whereas some are above. On the observation of this, there is need to formulate the adsorbent of high potential value to achieve the pollutant mitigation in the process as well as ensure adequate treatment measures are taken to capture the sediments of the pollutant.

Table 1 shows the water analysis results of Bodo Creek water sample in terms of the physicochemical parameters and obtained results w ere compared with International Standard and the electrical conductivity value was above the recommended value as demonstrated in the Table 1. However, the other parameter values were within the recommended International Standard, it was observed that their values were low for Bodo Creek, influence the activity of the micro and macro organisms found within the environment.

Table 2 shows the water analysis results of River Nun water sample in terms of the physicochemical parameters and obtained results w ere compared with International Standard and the pH, turbidity, chlorine and electrical conductivity value was above the recommended value as demonstrated in the Table 2. However, the other parameter values were within the recommended International Standard, it was observed that their values were low but still influence the water quality.

Table 3 shows the clay soil analysis results obtained in Oboburu community in terms of the composition and characterization parameters and obtained results were compared with International Standard and the value obtained reveal the stability of the clay soil in recommendation to the International Standard.

Table 4 shows the diesel (AGO) analysis results obtained in NNPC product in terms of the composition and characterization parameters and obtained results were compared with International Standard and the value obtained reveal the stability of the diesel in recommendation to the International Standard.

Table 1. Water Analysis Results of Bodo Creek water sample.

S/No	Parameter	Test Method	Result	Standard
1	pH	ALPHA 4500 HB	6.7	6.5 – 8.5
2	Chloride (mg/l)	ALPHA 4500 Cl B	91.16	250
3	Sulphate (mg/l)	ALPHA 4500 SO_4	65.17	400
4	Total Hardness (mg/l)	ALPHA 2340 C	66.81	500
5	Turbidity (NTU)	ALPHA 2130 B	2.19	5.0
6	Total Dissolved Solids (mg/l)	ALPHA 2510 B	142.10	500
7	Conductivity (µs/cm)	ALPA 2510 B	194.50	<100
8	Total Iron (mg/l)	ALPHA 3111 B	0.129	0 – 0.3
9	Alkalinity (mg/l)	ASTM D1067D	103.50	400
10	Nitrate (mg/l)	EPA 3521	2.14	10.0
11	Oil & Grease (mg/l)	ALPHA 3111 B	3.9	10.0
12	Dissolved Oxygen (mg/l)	AATM D3921	7.81	<7.0
13	Acidity (mg/l)	ALPHA 3111 B	0.047	<5.0
14	Phosphate	ALPHA 3111 B	53.21	<100
15	Temperature (°C)	ALPHA 500 T	28.10	-
16	Total Hydrocarbon Content (mg/l)	ALPHA 3111 B	4.22	10.0

Table 2. Water Analysis Results of River Nun Water Sample.

S/No	Parameter	Test Method	Result	Standard
1	pH	ALPHA 4500 HB	8.97	6.5 – 8.5
2	Chloride (mg/l)	ALPHA 4500 Cl B	11,480.3	250
3	Sulphate (mg/l)	ALPHA 4500 SO_4	228.5	400
4	Total Hardness (mg/l)	ALPHA 2340 C	96.32	500
5	Turbidity (NTU)	ALPHA 2130 B	3.58	5.0
6	Total Dissolved Solids (mg/l)	ALPHA 2510 B	399.73	500
7	Conductivity (µs/cm)	ALPA 2510 B	1,216.20	<100
8	Total Iron (mg/l)	ALPHA 3111 B	0.231	0 – 0.3
9	Alkalinity (mg/l)	ASTM D1067D	323.38	400
10	Nitrate (mg/l)	EPA 3521	6.38	10.0
11	Oil & Grease (mg/l)	ALPHA 3111 B	4.19	10.0
12	Dissolved Oxygen (mg/l)	AATM D3921	9.36	<7.0
13	Acidity (mg/l)	ALPHA 3111 B	0.372	<5.0
14	Phosphate	ALPHA 3111 B	58.60	<100
15	Temperature (°C)	ALPHA 500 T	30.21	-
16	Total Hydrocarbon Content (mg/l)	ALPHA 3111 B	6.85	10.0

Table 3. Soil Analysis Results of Clay Soil sample from Oboburu.

S/No	Parameter	Test Method	Result	Standard
1	pH	ASTM D51	5.98	> 5.0
2	Chloride (%)	BS 812	0.318	< 1.0
3	Sulphate (%)	BS 812	0.255	< 0.4
4	Nitrogen (%)	BS 1377	54.60	< 75
5	Silicon Oxide (%)	BS 1377	50.16	< 80.0
6	Phosphorus (%)	BS 1377	0.351	< 0.5
7	Conductivity (µs/cm)	BS 1377	1159.30	-
8	Ferric Oxide (%)	ASTM C114	0.213	0.5max
9	Organic Matter (%)	BS 1377	3.70	2.0 – 5.0
10	Total Hydrocarbon Content (%)	BS 1377	5.15	< 10.0
11	Organic Impurities	ASTM C40	Light Yellow	Light Yellow
12	Organic Carbon (%)	ASTM D3921	4.08	2.0 – 5.0

Table 4. Diesel Analysis Results of Diesel sample from NNPC Filling Station PH.

S/No	Parameter	Test Method	Result	Standard
1	Total Acid Number (mgkoH/g)	ASTM D 974	0.063	0.2 Max
2	Carbon Residue (%)	IP 131 B	0.40	2.0 Max
3	Sulphate Ash (%)	IP 163	0.611	1.35 Max
4	Water Content (%)	IP 74	< 0.01	< 0.01
5	Kinematic Viscosity @ 30ºC 60ºC	IP 71	2.4 1.6	2 – 6 1 – 4
6	Total Base Number (mgkoH/g)	IP 276	1.60	5.0
7	Pour Point (ºC)	IP 15	-14,0	< -16
8	Flash Point (ºC)	IP 34	230.80	52 – 96
9	Density @ 15ºC (g/cc)	IP 60	0.851	0.85 0.90
10	Total Sulphur (%)	ASTM D5453	2.91	2.0 Max
11	Diesel Index (min)	ASTM D47	75.50	46 Min
12	Sediment (%)	IP 75	0.81	2.0 Max
13	Colour (Hazen)	ASTM D6040	1.08	2.0
14	Appearance	Physical	Light Brown	<Light Brown

Table 5. PMS Analysis Results of Petrol sample from NNPC Filling Station PH.

S/No	Parameter	Test Method	Result	Standard
1	Total Acid Number (mgkoH/g)	ASTM D 974	0.02	0.1 Max
2	Carbon Residue (%)	IP 131 B	0.05	1.0 Max
3	Sulphate Content (%)	IP 163	0.012	0.15 Max
4	Water Content (%)	IP 74	< 0.01	< 0.01
5	Viscosity @ 15ºC	IP 71	0.886	< 1.0
6	Refractive Index	ASTM D1218	1.3120	< 1.4450
7	Pour Point (ºC)	IP 15	-24.0	< -36
8	Flash Point (ºC)	IP 34	45.0	< 70.0
9	Density @ 15ºC (g/cc)	IP 60	0.768	0.75 0.77
10	Suspended Matter (%)	ASTM D6560	Nil	Nil
11	Boiling Point	ASTM D47	75.50	210 Max
12	Sediment (%)	IP 75	, 0.01	0.1 Max
13	Colour (Hazen)	Physical	Orange	Orange
14	Appearance	Physical	Clear & Bright	Clear & Bright

Table 6. Fibre Analysis Results of Plantain & Banana samples.

Parameter	B_{OR}	P_{A1}	P_{OR}
Potassium	11173.91	12026.09	11086.95
Ammonia			
Phosphorus	72.89	14.22	53.33
Nitrogen	0.05	1.59	3.58
Sulphur	45.38	53.40	35.15
Iron	49.13	76.29	255.03
Copper	6.76	0.43	1.41
Manganese	2950.00	1500.00	5566.67
Silica	3900.00	381.81	2536.36
Chlorine		56.32	73.37

Table 5 shows the diesel petrol motor spirit (PMS) analysis results obtained in NNPC product in terms of the composition and characterization parameters and obtained results were compared with International Standard and the value obtained reveal the stability of the PMS in recommendation to the International Standard

Table 7. Analysis Result of the following Physiochemical Parameters of Plantain Ogoni Red, Banana Ogoni Red, Banana Native, Plantain Agbagba 1, Plantain Agbagba 2, 34 Banana and Clay.

S/N	Parameter	POR	BOR	BN	PA1	PA2	34B	Clay
1	Moisture Content (%)	-	-	-	-	-	-	32.10
2	Porosity (%)	87.9	88.5	90.02	89.7	91.15	89.7	51.0
3	CEC (meq/100g dry wet)	-	-	-	-	-	-	7.96
4	Bulk density (g/cm^3)	0.56	0.53	0.51	0.55	0.54	0.52	1.41
5	Hydraulic conductivity cm/s							$1.383x10^{-9}$
6	pHzpc (for clay) and others	4.63	4.80	4.74	5.01	4.82	4.58	4.49
7	Mineralogy							
	SO_3	-	-	-	-	-	-	0.41
	Fe_2O_3	-	-	-	-	-	-	2.99
	MgO	-	-	-	-	-	-	1.73
	Al_2O_3	-	-	-	-	-	-	30.42
	CaO	-	-	-	-	-	-	0.15
	SiO_2	-	-	-	-	-	-	65.11
	K_2O	-	-	-	-	-	-	2.18
	Na_2O	-	-	-	-	-	-	0.062
8	Particle Size Distribution (%)							
	Sand	-	-	-	-	-	-	7.09
	Clay	-	-	-	-	-	-	85.00
	Silt	-	-	-	-	-	-	8.00
9	Organic Matter (%)	93.1	95.3	90.8	92.9	93.7	94.6	N/A
10	Organic Content %	68.6	70.1	69.2	63.5	58.5	60.3	-
11	P (mg/g)	0.061	0.059	0.056	0.063	0.058	0.057	-
12	K (mg/g)	4.7	5.1	2.5	3.0	6.0	9.7	-
13	N (mg/g)	57.4	61.3	59.2	56.8	56.9	58.6	-

Table 6 shows the fiber analysis results obtained in plantain and banana species used in carrying out this research and its properties in terms of the composition and characterization parameters and obtained results revealed that the agro-based material possesses the potential to perform such function.

Table 7 shows the physicochemical analysis results of plantain and banana species used in carrying out this research and their properties in terms of the composition and characterization parameters and obtained results revealed that the agro-based material possesses the potential to perform such function.

CONCLUSION

Considering the extent of this research and our findings, the following conclusions are projected for further research to be carried out. Conclusion includes the followings:

1. Effect of microbial activity should be monitored alongside with adsorption process.
2. Effect of other particle size and mixed ratio should be considered in adsorption process using clay soil and agro-based materials.
3. The causes of leaching that occurred in this process should be studied and its effect on the rate of adsorption to be established.
4. The adsorption isotherms of the elements monitored should be established using the Langmuir, Freundlich and Temkin adsorption isotherms including the evaluation of pseudo first and second order adsorption kinetics.
5. The possible inhibiting factors for effective adsorption process to occur using bio-based adsorbents.

6. Effect of temperature on the adsorption process of bio-based adsorbent in adsorbing crude oil-based product in elevated temperature of above room temperature.
7. Consider effect of other species of the agro-based materials used for the purpose of comparison in terms of performance.

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