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Efficiency of Activated Carbon Produced from Rice Husk in Water Treatment

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Abstract: Activated carbon has been there with us for centuries. It has wide applications in various industries, water-treatment, dye, sugar refining among others. Water pollution is one of the pressing environmental issue facing Nigeria. The production of activated carbons locally and from locally available materials would be one of the most lucrative and environment-friendly solutions to this as it would transform negative–valued wastes to valuable materials. Thus, the main objective of this research was to prepare activated carbons from rice husk using a chemical activation method with phosphoric acid as an activating agent and to determine its efficiency in water treatment. Before the application of activated carbon, results of pH (6.5), electrical conductivity (1789µs/cm) and turbidity (38.8NTU) were all above WHO standard for drinking water quality with exception of pH. Meanwhile after the application of activated carbon produced from rice husks, results of pH, electrical conductivity and turbidity were 6.7, 397µs/cm and 0.2NTU respectively which were all within the permissible limit. After the completion of this research, the results of the test have shown that activated carbon from rice husk has a high efficiency to treat water pollutants in an eco-friendly manner.

Keywords: Wastewater, Activated carbon, Rice husks, Water treatment, Physicochemical

I. INTRODUCTION

The availability of pipe-borne water, borehole water and shallow wells in rural and urban areas is an indication that water is a vital constituent of human existence [1]. The quality of water that human beings consume is critical in determining the quality of their lives [2]. The World Health Organization has frequently claimed that the single major factor adversely influencing the general health and life expectancy of a population in many countries is accessibility to portable water [3]. In the same vein, World Health Organization [4] predicted that in the next thirty years alone, accessible water is not likely to increase more than ten percent (10%) but the earth's population is expected to rise by nearly one-third. Except the efficiency of water use increases, this inequality will reduce quality water services, reduce the conditions of health of people and deteriorate the environment and the world. The speed at which cities are growing is alarming in the sense that human population with its associated sanitation and pollution problems will grow faster than increases in the amount of accessible quality water [5]. This necessitate the need for coming up with environmental friendly techniques like activated carbon for treating this precious resources to achieve sustainable development, live in harmony with environment and abate future water crisis. Activated carbon (AC) is a material with a high degree of absorbency and an extended surface area [6]. More than 90% of activated carbon contains of the carbon element. Activated carbon have various use in the environmental discipline, industrial and other fields for removal, recovery, separation and alteration of a variety of species in liquid- and gas-phase applications. Its application cover treatment of water pollutants. Recent studies has revealed that activated carbon has the capability to remove gas pollutants such as nitrogen oxide [7]. The research on how to produce an activated carbon with high-efficiency in developing countries is still in progress. The utilization of agricultural waste might be the key to a healthy transformation and reduce waste of resources. Agricultural waste was produces in each and every country, which can be an indicator on the type of agricultural activities commonly practice in the country. These agricultural wastes can be converted into an asset when properly utilized. However, in Nigeria rate of agricultural waste produced yearly is increasing and the widespread method of disposing these waste is open burning, which could results to air pollution in the environment. The only promising method of controlling Agricultural waste is by transforming it into useful material which will indirectly reduce environmental pollution [8].

Recently, continues environmental awareness on effects of effluents discharge into water bodies leads to purification of wastewater prior to disposal into the environment. A number of conventional treatment technologies was employed for treatment of waste water contaminated with organic substance [9]. Among them, the adsorption process has been consider to be one of the effective method whereas activated carbon is observed as the most effective material for controlling this organic load [10]. Earlier active carbons are usually developed by heating activating agents at ovens, thus producing activated carbons which take a longer time with inadequate pore structures. With the advent of microwave technology, a better and efficient activated carbon can be produced within a short period and at affordable rate [8]. The raw materials such as rice husk, corn cobs, saw dust, sugarcane bagasse which can be used to produce activated carbon are readily available and inexpensive. Previous studies have shown that agricultural waste have successfully proven to be a suitable raw material for activated carbon production. These include corn cobs, mango Steen peel, rice straw, nuts, rubber wood, sawdust, durian shell and mango peanut shell. In this research, agricultural waste known as rice husk will be used to prepare activated carbon using phosphoric acid activation for water treatment.

II. NEED FOR THE RESEARCH

Countries are continuing to become industrialized daily which results in water pollution coupled with consumption while exponential population growth more importantly in developing countries leads to the serious need of water and search for techniques of treatment of contaminated water to meet the needs of people. Activated carbon was regarded as one of the best cost-effective and eco-friendly methods of water treatment. It also increases the positive use of agricultural wastes that readily available, including banana peels, sawdust, sugarcane bagasse, rice husks among others in the purification of water rather than disposing of these materials that create environmental problems and ecosystem instability. More so, proper utilization of agricultural waste can create a source of income for the public and boost revenue to the government. This means that when these waste materials properly utilize can turn to an asset instead of liability and burden.

III. RESEARCH METHODOLOGY

A. Materials and Equipment

In this research, the material is rice husk and this raw material was bought from the market. Therefore, number of population is irrelevant to this research work. While equipment used include hand gloves, oven, muffle furnace, pestle and mortar, sieve, spatula, tube, beakers, pH meter, conductivity meter, turbidity meter, filter paper, conical flask, petri dish, weighing balance, measuring cylinder and glass rod.

B. Experimental design

Quantitative design was employed for this study in which the physicochemical parameters were analyzed in the laboratory and some in the field immediately after the samples were taken. Rice husks is the raw materials used for the preparation of activated carbon (AC) in this research to determine its efficiency in water treatment.

C. Field and laboratory work

The collection of the raw materials was done within Sabon-gari market Zaria, Kaduna State, Nigeria and also the water sample was collected from a particular borehole located at the centre of the market used by the people. The material (rice husks) used was washed thoroughly before cutting it into smaller sizes. The materials was preserved for a period of three days to rotten. The dried sample was then washed again gently with water and sundried it. Finally, the dried sample was grinded using pestle and mortar followed by sieving it with a 2mm mesh size sieve which gives out a smoother particle in powdered form.

D. Carbonization and chemical activation

The carbonization of the sample materials was done in the absence of air in a muffle furnace at a temperature of 550^{o}C for 2 hours 30 minutes. 50g from each of the carbonized sample was mixed with an aqueous solution of phosphoric acid (activating agent) for the materials at 1:3 wt. ratio for each sample. After that, the sample material was subjected to an oven at 120°C for 30 minutes. The resulting carbons was washed with distilled water until the pH of the leachate is stable at 7 and dried mixture was subjected to oven again at 200°C for 3 hours to enable activation of the pores which finally produce the prepared activated carbon.

E. Determination of the adsorption capacity

2grams of activated carbon produced from rice husks was introduced into 150ml of water sample in a beaker in three places and allowed to stand for an equilibrium adsorption time of 60 minutes. Filter paper was used to filter the water samples. The determination of pH, Conductivity and turbidity in the water was done before and after interaction with the activated carbon. The experiment was repeated three times, and the average result was recorded.

F. Sampling technique(s)

Base on the nature of this research work, purposive sampling was used in the collection of the materials and the water sample used for the analysis.

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IV. RESULTS AND DISCUSSION

Activated carbon from rice husk was produced using chemical activation method and phosphoric acid was used as an activating agent. Fig. 1 shows the picture of the activated carbon produced.

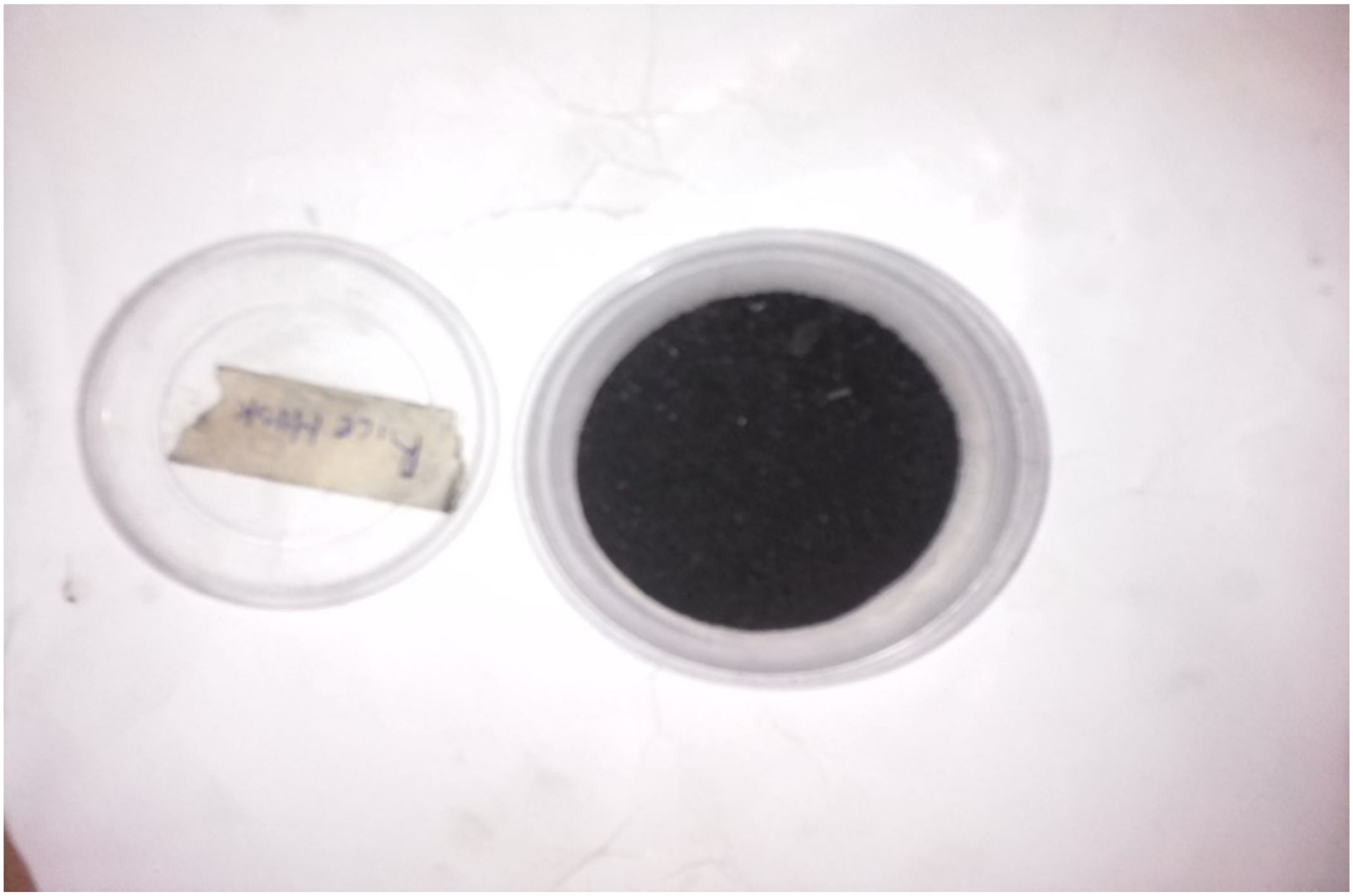

Fig. 1 Activated carbon produced from rice husk

The pH, conductivity and turbidity of the water sample were determined by monitoring these parameters before and after application of the activated carbon into the water sample collected. The pH of water indicates the level of alkalinity or acidity of water which can be used to determine the presence of pollutants in the water. When the level of electric conductivity (EC) of the water is low, it is an indicator of water is pure, hence if the relatively high values observed in water sample shows high contamination level which indicates that the water might not be suitable for domestic and industrial use while turbidity measures the clarity or cloudiness of water. Highly turbid water indicates that the water is not aesthetically appealing and is polluted. A test for effectiveness of the activated carbon used in the treatment of water was made. The results obtained after treating the water with activated carbon is then compared with the standard, to ascertain if three parameters are within the acceptable limit. The results obtained are presented in Tables 1 and Fig. 2 below.

Table I: ph, turbidity and conductivity of water before and after application of activated carbon and compared with who standard

Physicochemical Parameters	Result before application of rice husk AC	Result after application of rice husk AC	World health organization (WHO) standard for safe drinking water
pH	6.5	6.7	6.5 – 8.5
Conductivity	1789 µs/cm	397 µs/cm	1500 µs/cm
Turbidity	38.8NTU	0.2NTU	5 NTU

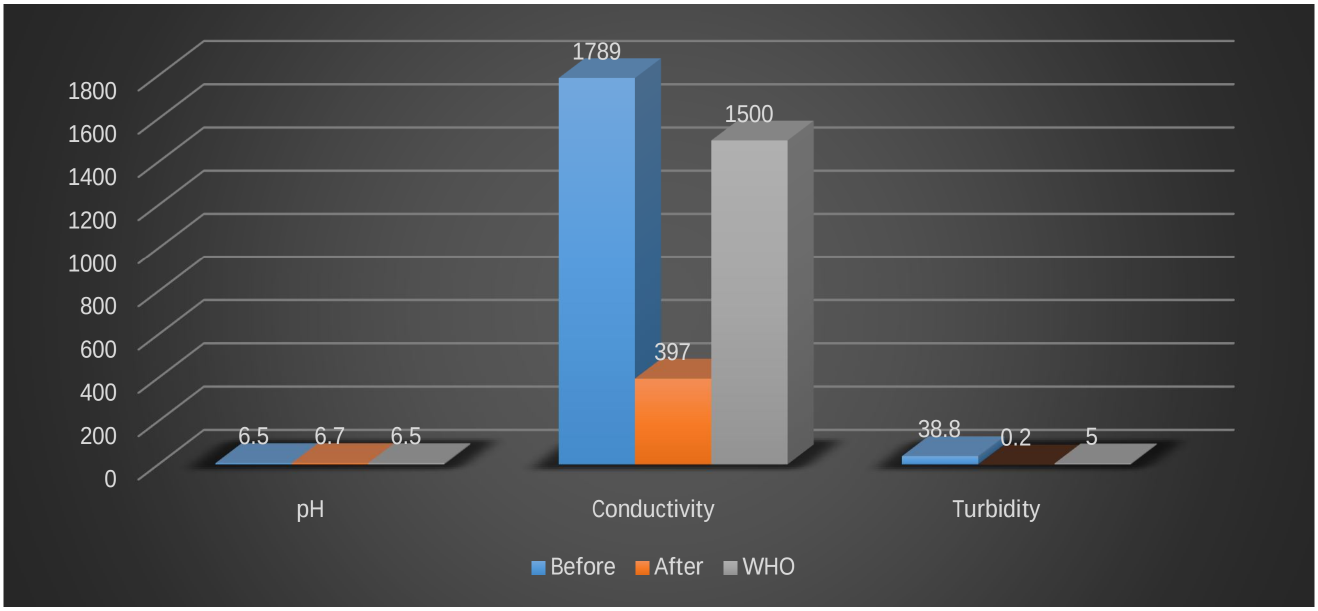

Fig. 2 pH, Turbidity and Conductivity of water before and after application of activated carbon and compare with WHO Standard

The pH value of 6.5 for the water sample was moderately acidic before the application of activated carbon as shown in Table 1 and Fig. 2. Instantly the pH changed to 6.7 after the application of activated carbon and both results of pH before and after application of activated carbon were within the permissible limit set by World Health Organization [11] for safe drinking water quality (6.5-8.5).
Based on the results obtained from this study, the electrical conductivity of water samples found to be 1789µs/cm which is far above the recommended limit set by WHO (1500µs/cm). After the water was treated with activated carbon produced from rice husks, electrical conductivity effectively reduced to 397µs/cm which is within the recommended limit as set by WHO. Hence the water is fit for both domestic and agricultural purposes.
Turbidity determines the clarity or cloudiness of water. High turbid water signifies that water is not aesthetically appealing and is polluted. The turbidity of water samples was measured and found to be 38.8NTU which exceeded the permissible limit set by WHO (5NTU). But after treating water samples with activated from rice husks, the turbidity dramatically turned 0.2NTU. This implies water becomes clean and can be utilized for many important purposes.

V. CONCLUSION

Based on results from this research which revealed that electrical conductivity and turbidity of water samples before application of activated carbon produced from rice husks exceed permissible limits set by WHO standard while pH is within the limit for safe drinking water quality. This implies that water is not suitable for domestic purposes among other vital purposes, but instantly after treating water samples with activated carbon, the results of pH, electrical conductivity and turbidity were found to be within the recommended limit of WHO standard. Therefore, this study concluded that activated carbon produced from rice husks has high efficiency to neutralize water pH, reduced electrical conductivity effectively as well as turbidity.

VI. RECOMMENDATION

An investigation should be made in further research in this area would improve the proper utilization of agricultural wastes like banana peels, sugarcane bagasse and corn cobs, etc. into activated carbon which can play a vital role in controlling environmental pollution. Extensive research and developmental work are needed to develop a national capability for the production of activated carbon which has several benefits such as, contributing to measures for abating the environmental degradation caused by improper dumping and open burning of agricultural and industrial wastes as well promoting a healthy environment. Most of the activated carbon used in Nigeria is imported, despite the abundance of agricultural wastes generated in Nigeria which can be used to produce activated carbon in sufficient quantities and create job opportunities for citizens.

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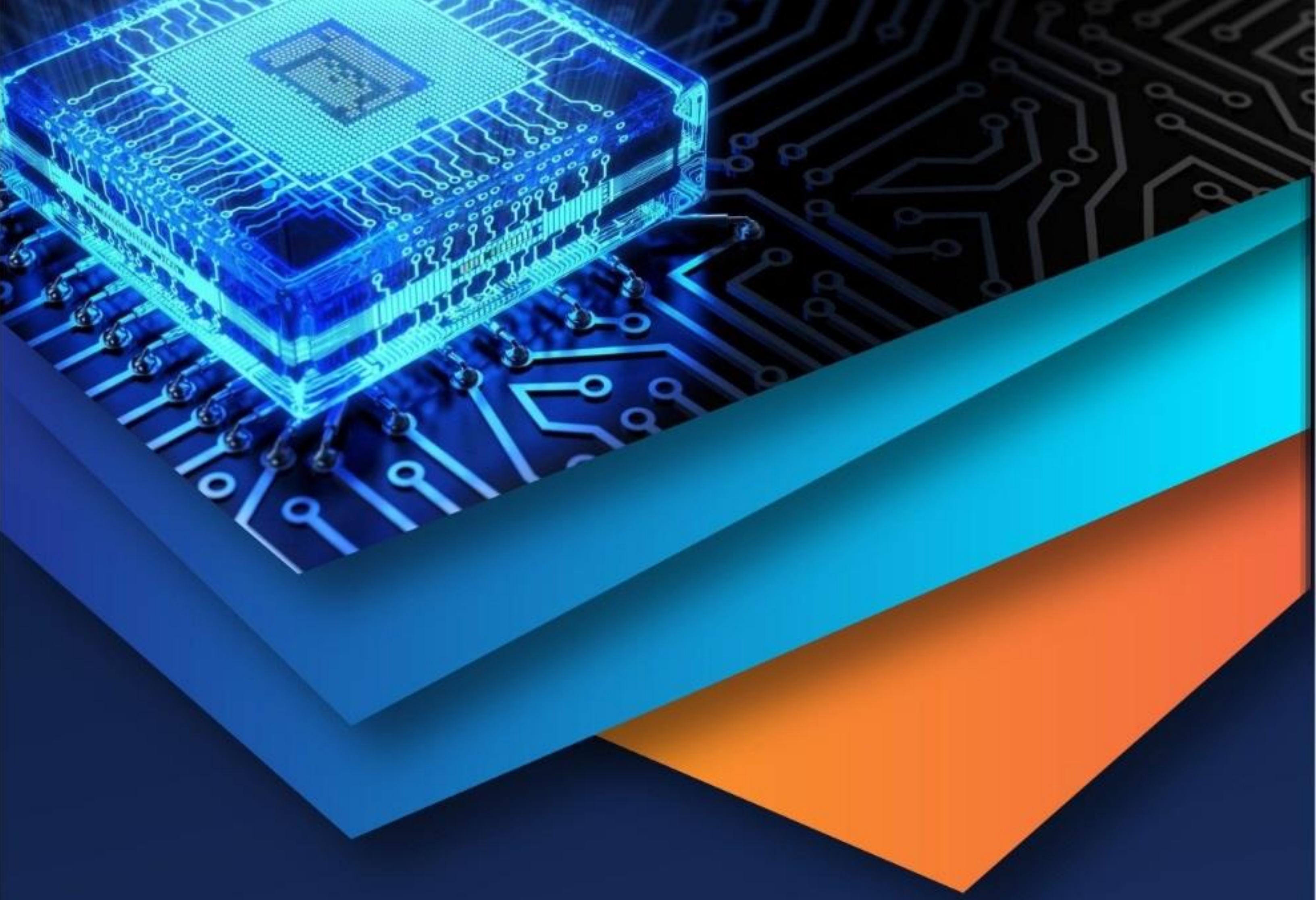

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