

Electrical Insulating Properties of Developed Composite Material from Palm kernel/Sawdust

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Abstract— This study was carried out to determine the electrical insulating properties of developed composite material from agro waste (sawdust and palm kernel shell). The sawdust: palm kernel shell composition used in the composite production were in the ratio of 100%: 0%, 90%: 10%, 80%: 20%, 70%: 30%, 60%: 40% and 50%:50%. Urea formaldehyde was used as the test binder at concentrations of 20% percentage of oven dry weight of agro waste and the particle size of agro wastes used was 300 μm . The electrical insulating properties of the produced composite materials were evaluated. The composite material electrical insulating properties improved with a higher percentage of palm kernel shell added. The produced composite material was found to be a good electrical insulator that is safe for use to a maximum of 2500V .

Index Terms — Agro waste, Composite, Electrical insulating properties, Sawdust, Palm kernel shell,

1. INTRODUCTION

An electrical insulator, also called a dielectric, is a material that resists the flow of electric current. These materials are used in parts of electrical equipment, intended to support or separate electrical conductors without passing current through themselves [1,2]. Some materials such as glass or Teflon are very good electrical insulators. A much larger class of materials, for example rubber-like polymers and most plastics are still "good enough" to insulate electrical wiring and cables even though they may have lower bulk resistivity [3].

It has been shown that technological development depends on the progress in the field of materials [4]. The research and development of new materials are, together with industry and design are necessary accomplices and the engine that drives economic progress. In the past twenty years, materials research and development has shifted from monolithic to composite materials, adjusting to the global need for reduced weight, low cost, quality, and high performance [5]. The demand for new materials with higher specifications led to the concept of combining different materials in an integral-composite one. Such composite materials result in performance that cannot be attained by the individual constituents[4].

Agricultural waste materials have become alternative raw materials for the production of composites. The use of

agricultural residues to manufacture composite appears to have environmental and economic advantages [6]. The physico-mechanical properties of the developed composite material from agro waste (sawdust and palm kernel shell) have previously been investigated [7]. This study therefore was to investigate the electrical insulating properties of the developed composite material from agro waste (sawdust and palm kernel shell).

II. MATERIALS AND METHODS

MATERIALS

Sawdust from mahogany and palm kernel shell were used in this study and these were obtained from Benin City, Edo State, Nigeria, while the binder employed urea formaldehyde was procured from Benin City, Edo State, Nigeria.

METHODS

Composite material production

The palm kernel shell was ground to granules. The palm kernel shell granules and sawdust were first air dried in the sun and latter transferred separately to an electric oven and dried at 105^oC. It was continuously monitored until moisture content of about $4 \pm 0.2\%$ was obtained. The sawdust and ground palm kernel shell were screened separately with sieves of appropriate size to particle size of 300 μm diameters using vibrating sieve machine. Urea formaldehyde was prepared by mixing thoroughly with water in ratio 3.5:1 parts, before being mixed with appropriate percentage of saw dust/palm kernel shell mixture as shown in the experimental design for the production of composite material in Table 1. The panels to be produced was with particle size of 300 μm and Urea formaldehyde binder concentration of 20% of the oven dry weight of agro waste [7,8]. The prepared binder was then blended with the weighted sawdust to palm kernel shell in appropriate proportion to ensure an efficient and proper coating of the agro waste with the binder.

The mixture was later poured into a mould measuring of 330 x 110 x 30mm and hot pressed at a temperature of 200^oC and a pressure of 26.5 kg/cm². Composite panel was produced according to the ratio in Table 1. The test pieces were exposed for 96 hours in an air conditioned room at a temperature of $20 \pm 3^{\circ}\text{C}$ and relative humidity of $65 \pm 1\%$ to obtain constant weight [9]. The produced composite is shown in Fig. 1.

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Electrical insulation test

Electrical Insulation resistance measuring device “The Megger” (model No:AM-5KV) was used to measure the insulation resistance of the composite materials. Copper plates with terminal heads was placed on both side of the composite material and voltage of 250V passed through the composite material. The insulating resistance was then read from the instrument in MΩ. The same process was repeated with voltages of 500V,1000V,2500V and 5000V through all the composite materials of various constituent composition and their corresponding insulating resistance values read from the instrument. The leakage current was then determined by Eqn. 1.

$$I = V/R \text{-----(1)}$$

were V is voltage , R is resistance, I is leakage current .

III. RESULTS AND DISCUSSION

Fig.2 shows the graph of composite material insulation resistance (MΩ) against applied voltage (V) for various constituent composition of composite material , while Fig.3 shows the graph of applied voltage(V) against leakage current (mA) for various constituent composition of composite material. It was observed that the insulation resistance of composite material experienced an increase as the percentage palm kernel shell granules in the composite increased and sawdust decreased. For example at a voltage of 2500V the insulation resistance for composite material with constituent composition of 60%:40% (sawdust: palm kernel shell granules) was 485 MΩ while for 90%:10% constituent composition insulation resistance was 455 MΩ. The same trend was observed at all voltage. It was observed that the insulation resistance of composite material experienced a slight increase as the voltage increased, but insulation resistance drastically decreased when the applied voltage was increased to 5000V which implied that voltage breakdown was beginning to set in ,though breakdown have not been fully experienced for all consistent composition tested. It was observed that the composite material with optimum electrical insulating properties is the one with constituent composition of 50%:50% (sawdust :palm kernel shell) with an insulating resistance of 490 MΩ. We can therefore conclude that the produced composite material is a good electrical insulator that is safe to a maximum voltage of 2500V. These composite materials can serve as practical and safe insulators for low to moderate voltages up to a maximum of 2500V.It was also observed that the determined leakage current experienced slight increase as the voltage increased. For instance, for composite constituent composition 50%:50% (sawdust: palm kernel granules) when the applied voltage was 250V ,the leakage current was 0.0005mA, but when the voltage increased to 1000V, the current was 0.005mA (Fig. 3).It was also observed that the leakage current ranged between 0.0005 -0.005mA for a maximum voltage of 2500V.This was small and below the value of 0.01mA that is very safe [2].

IV. CONCLUSIONS

The electrical insulating properties of developed composite material from agro waste (sawdust and palm kernel shell) have been investigated. The overall composite material electrical insulating properties improved with a higher percentage of palm kernel shell added. The composite materials can serve as practical and safe insulators for low to moderate voltages up to a maximum of 2500V

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Table 1: Compositions of the composite material

omposite material	Sawdust (%)	Palm kernel Shell (%)
A	100.00	0.00
B	90.00	10.00
C	80.00	20.00
D	70.00	30.00
E	60.00	40.00
F	50.00	50.00



Fig. 1: Produced composite material

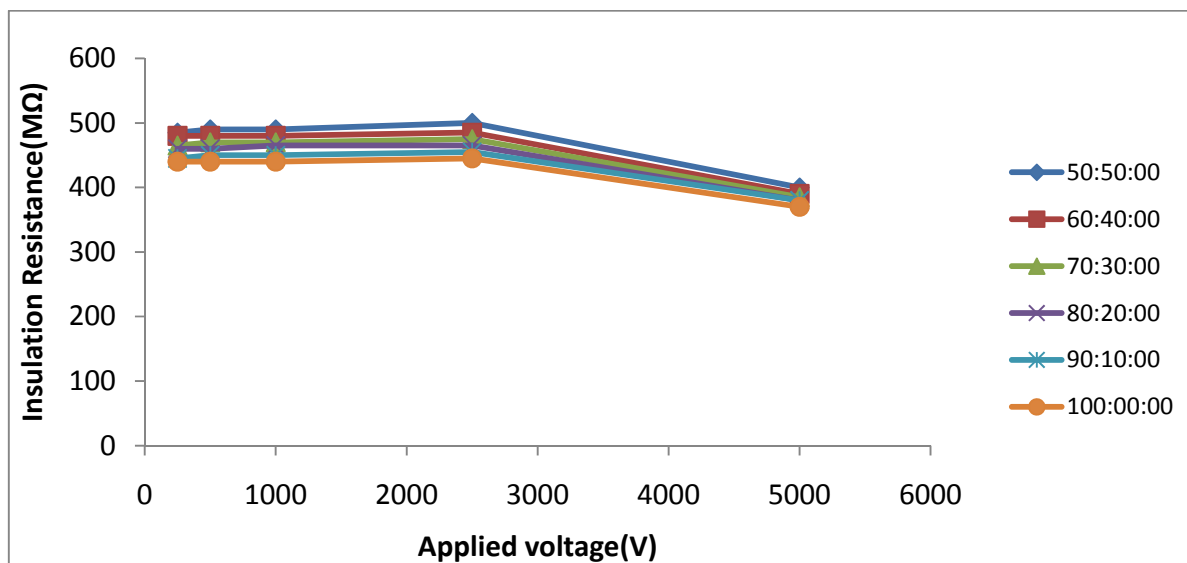


Fig. 2: Insulation resistance (MΩ) against applied voltage (V) for composite material with different constituent (sawdust: palm kernel shell)

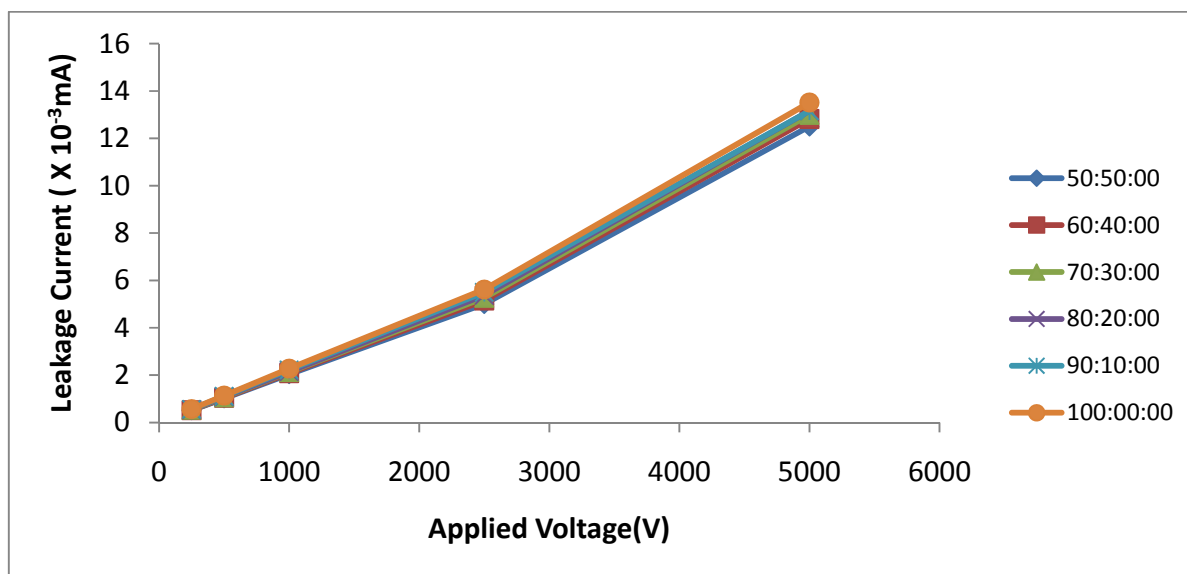


Fig. 3: leakage current (mA) against applied voltage (V) for composite material with different constituent composition (sawdust: palm kernel shell).