Preparation of Carbon Brushes from Agro-Waste Materials Palm Kernels Shells for Automobile Industry

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Abstract
The carbon brush is mainly applied in a rotating shaft as an electrical contact in conducting current between static wires and moving parts. It is applied majorly in electric motors, alternators, and electric. The automobile industry has recently developed rapidly in the world with numerous novel kinds of motors with low power and high speed. The materials that are utilized in the manufacture of carbon brush are copper metal, amorphous carbon, graphite, retort cokes, petroleum coke, binders, lubricants, and some other metal powders serving various purposes. The major part of the carbon brushes is carbon which can be derived from carbonaceous materials such as agro-waste. The agro-waste of palm kernel shell was prepared through pyrolysis using an anaerobic furnace at 500 ^{o}C – 800 ^{o}C for five hours to obtain carbonaceous material. The carbon which is the main component was activated at this temperature using the physical activation method. The samplers produced contained copper, zinc, and molybdenum disulphide as a lubricant with a resin binder in a different ratio. The samples were characterized by several testing. The results showed that the hardness, bending strength 1125 N/mm^2, resistivity 14 μΩcm, and bulk density 1026 g/cm^3. These were compared with control samples from the industry which have Brinell hardness 398.22 BHN, bending strength 1305 N/mm^2, resistivity 22 μΩcm, and bulk density 1104 g/cm^3. From the comparison result, the properties measured of the sample fell within a reasonable range with the industry carbon brush. In conclusion, the result demonstrates that agro-waste such as palm kernel shell is a viable means in the production of carbon brushes for the automobile industry

Keywords: Carbon Brush, Palm Kernel Shell, Electric Machines, Anaerobic Furnace.

1. Introduction

Electrical machines have been in use for many years. A key component of the direct current (DC) machine is the carbon brush. A carbon brush can be defined as a component which transmits electric current between the static and rotating part of the motor, this component has both electrical and mechanical functions within the machine [1]. It contains electricity within the surfaces it comes in contact with and is also subjected to mechanical forces as the components come in contact during motion [2, 3]. Carbon brushes are a key component in the starting system of an automobile. The development of carbon brushes helped the commutation process remains free from sparks. Commutation can be basically defined as the reversal of current in the armature winding, thus the process is necessary to maintain a unidirectional torque in a DC motor. The rotating speed of the motors often outstrips 10 000 revs/min to 30 000 revs/min. The brushes secured in the automobile have exceptional commutation capability, enormous sparks, and great noises generated between brushes and commutators. This resulted in the quick wearing of

brushes and a short life- span. [4, 5]. The various materials used in the fabrication of carbon brush are copper metal, amorphous carbon, graphite, retort cokes, petroleum coke, binders, lubricants, and some other metal powders serving various purposes. The main component of the carbon brush is carbon which can be derived from carbonaceous materials such as agro-wastes. In this work, we aim to reduce the use of graphite as a raw material to create a carbon brush, instead replace it with palm kernel shells to be used in automobile applications.

2. Experimental

The agro-waste of palm kernel shell was prepared through pyrolysis using an anaerobic furnace at 500 ºC – 800 ºC for five hours to obtain carbonaceous material as described by [6]. Several processes such as baking, crushing, sieving, mixing, compacting and sintering are used in this work to fabricate the product. The samplers produced contained copper, zinc, and molybdenum disulphide as a lubricant with resin binder in a different ratio. The activated carbonaceous raw material was crushed using tubular shakes mixed to produce smooth particulates size of carbon powder as described by [7]. The crushed powders are then sieved to produce the particulate sizes needed for the production. It was sieved for about 20 minutes before the blending process. Afterwards, cold compaction process was carried out using mechanical carver hydraulic press machine at room temperature. The sample is dimensioned 1.5cm in diameter and 1cm in height. The 6 tons of pressure was applied for 5 minutes on the 3 gram of mass powder. The green body sample was produced and sintered at a temperature of 800 ºC with a flow rate of 0.51/ min.
The characterization and testing of the sample will be based on four kinds of parameters which are in the properties of electrical (current), mechanical properties (hardness), and (bending strength) and physical properties (bulk density).

3. Result and Discussion

The produced carbon brush from the activated agro-waste material palm kernel shell is to be used in the automotive industry. The characteristic of the carbon brush produced and the existing industry standard which was used as a control sample is shown in the Table1.

Table 1: Produced sample and control one with their characteristics properties

Material sample	Resistivity (μΩcm)	Bulk density (g/cm^3)	Hardness (BHN)	Bending strength (N/mm^2)
Control sample	22	102.6	398.22	1305
Prepared sample	14	1104	394.867	1125

Carbon brushes are of great resistivity induced by the insulation of its binders having decent commutation ability suitable for the high- speed motors [5] as showing in Table 1. The other properties are very close to the control sample used in the industry. From this preliminary result, it can be concluded that agro-waste such as palm kernel shell is a viable means in the production of carbon brushes for the automobile industry. The bulk density was high with 1104 g/cm^3 compared to 102.6 g/cm^3 of the crystal sample. This implies that the agro-waste particles have a high tendency for strengthening characteristics as attested by [8]. On the other hand, a massive improvement was also noticed with hardness characteristic. It is important to mention that an interfacial response of agro-based particles often provides excellent build-up that could impact hardness performance. Thus, [9] affirmed that particulates induced of material for structural

improvement are basically a function of individual activities of the organic matters with 394.867 BHN, a better hardness was noted. Although, the prepared sample obtained a low bending strength lesser than the control samples and this might be as a result of thickness variation or design specification.

4. Conclusion

The application and performance of carbon brush after successful production was examined. It was seen that the effect of palm kernel gave significant enhancement toward the performance quality of the produced carbon brush. A lower resistivity of 14 μΩcm was obtained with slight micro hardness improvement of over the crystal samples. It is however concluded that the use of agro-based organic matter is essential, other possible materials additive could be examined for high technology application.

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