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Short Communication

Effect of load on the wear behaviour of polypropylene/carbonized bone ash particulate composite

F. Asuke [a,b], *M. Abdulwahab* [a,b], *V.S. Aigbodion* [c,*], *O.S.I. Fayomi* [b,d], *O. Aponbiede* [a]

[a] *Department of Metallurgical and Materials Engineering, Ahmadu Bello University, Zaria, Nigeria*
[b] *Department of Chemical and Metallurgical Engineering, Tshwane University of Technology, Pretoria, South Africa*
[c] *Department of Metallurgical and Materials Engineering, University of Nigeria, Nsukka, Nigeria*
[d] *Department of Mechanical Engineering, Covenant University, Ota, Ogun State, Nigeria*

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ABSTRACT

The effect of applied load on the wear behaviour of polymer matrix composites produced using carbonized bone particles (CBp) as reinforcement has been studied. The addition of the CBp ranges from 5 to 20 wt% in the polypropylene matrix. The composites were produced by compounding and compressive moulding. The wear test was conducted by varying the applied load from 5 to 15 N. Microstructures of the worn surface were assessed with high resolution scanning electron microscopy (HRSEM/EDS). The wear rate increased with increases in applied load from 5 to 15 N and decreased with increasing in CBp from 0 to 15 wt%. The work has established that carbonized bone can be use in increasing the wear resistance of polypropylene composites.

1. Introduction

The use of composites as another class of engineering materials is very vital to the success of any industrialized nation. Numerous research institutes adopted the challenge of developing and improving the existing composites. Record available shows that the present global consumption is continually increasing [1,2].

* *Corresponding author*. Tel.: +234 8028433576.
E-mail address: aigbodionv@yahoo.com (V.S. Aigbodion).
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Aigbodion et al. [3] studied the tribological behaviour of recycled low density polyethylene (RLDPE) polymer composites with bagasse ash particles were studied using a pin-on-disc rig. There results showed that the addition of bagasse ash in RLDPE composites increased the wear resistance of the composite.

Vishwanath et al. [4] reported on wear of both polyester and phenolic reinforced glass fibre composites. They observed that in both case of composites 30 wt% of resin gives low wear and coefficient of friction, also with resin beyond 30 wt% resulted to a higher wear rate.

Unal et al. [5] studied pure polytetrafluoroethylene (PTFE) and its composites and noted that with increase in load the friction coefficient decreased. In case of wear rate, maximum reduction occurred with 17 wt% glass fibre reinforced PTFE. Also it is reported that adding fillers such as carbon and bronze along with PTFE, reduction in wear rate was found to be better.

Suresha et al. [6] reported that increase in sliding velocity/load increases the sliding wear loss. In particular, the sliding wear behaviour of 10 wt% graphite filled glass epoxy composites was better when compared to unfilled and lower graphite filled carbon fibre reinforced epoxy composites.

Nagaraju et al. [7] carried out wear studies on polyester resin filled with ZnO nano particles. It is shown that the addition of filler graphite improves the wear resistance to a much greater extent along with glass fibre reinforced epoxy composites when compared with other sample combinations.

Basvarajappa et al. [8] carried out wear studies on glass fibre reinforced epoxy composites along with fillers of SiC and graphite. The wear resistance of the composites increases by the addition of fillers to a greater extent. In addition using Taguchi approach the optimal parameters on the wear studies were reported. It is also reported that load and sliding distance were the factors that influence the wear more rather than the sliding velocity.

Mahapatra and Vedansh Chaturvedi [9] studied the abrasive wear behaviour of untreated sugarcane reinforced polymer composite and developed empirical model using neural network. Also using Taguchi method the optimal parameter of wear was reported.

Atuanya et al. [10] reported on the empirical models for estimating the thermal and wear properties of developed composite material from recycled polyethylene/Breadfruit seed hull ash particulate (BFSHAp) composites. There results obtained showed that for the thermal analysis the temperatures of weight loss range from 10 to 100%. The wear rate, the sliding speed ($p = 0.0021$), applied load ($p = 0.0060$), BFSHA $p(0.0060)$ has the great influence on the wear behaviour of the developed composites. The interaction between applied load/BFSHAp (0.0061) also has an influence on the wear.

Recent publication of the author and his co-workers [11] studied the effect of bone powder on the physical and mechanical properties of polypropylene composite. From this survey it is clear that work on wear behaviour of cow bone powder has not been reported by researchers. Hence an investigation is prepared to carryout experimentation on wear behaviour of carbonized bone particles reinforced polymer composites.

2. Materials and method

2.1. *Materials*

Polypropylene, cow bone (carbonized), set of sieves, hacksaw, wear tester, two roll mill, hydraulic press, crucible furnace and scanning electron microscope.

2.2. *Method*

Cow bones (limb bones) were washed and cleaned. The bones were carbonized in a crucible furnace at 550 °C for 45 min [6]. Bone crusher was used to crush the bones to particles size (≤2 mm) and ground to ≤1000 μm by replacing crusher sieve with 1 mm sieve. Sieving was done using set of sieves having mesh sizes of 1000, 750, 500, 250 and 100 μm diameter to obtained small particle size. After sieving, the under size of 100 μm was used as reinforcement.

Compounding was done not only to mix but also to ensure intimate mixing of composite forming constituents. The two roll mill machine, was switched on and set for preheat to a temperature of 180 °C for 1 h [4]. The polypropylene (Fig. 1a) was introduced when the two rolls were just closed by regulating the gap between them. After two minutes, measured amount of CBp (5, 10, 15 and 20 wt%) were introduced (Fig. 1b). The mixture was left for eight minutes to achieve effective homogenization. The mixture was then ejected and allowed to cool. The blend material was pressed using hydraulic press at elevated temperature (≈180 °C). The compact was removed while still hot to obtain smooth surface (Fig. 1b).

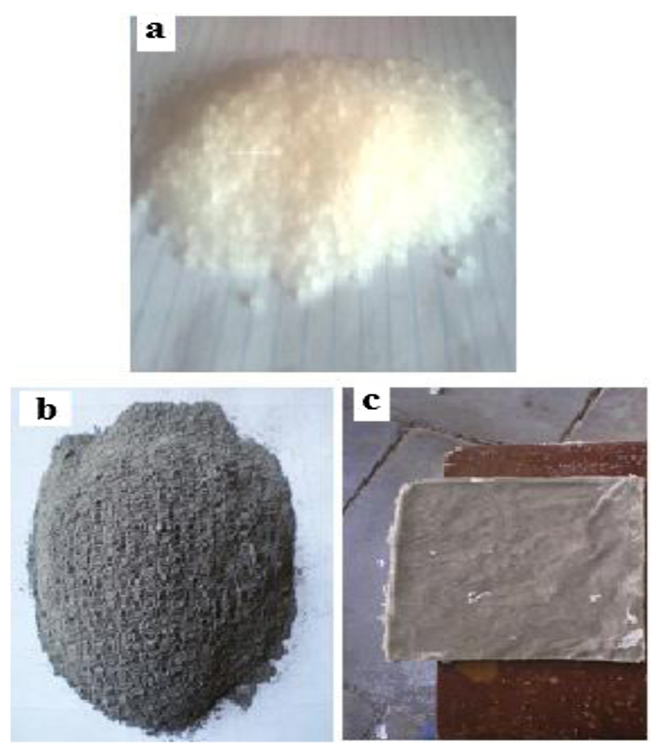

Fig. 1 – Photographs of a) polypropylene, b) carbonized bone powder (CBp), c) pressed PP/bone composite.