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Characterization and Wear Behavior of Carbon Black Filled Polymer Composites

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Abstract

Carbon black derived from wood apple shell, was obtained by pyrolysis of wood apple shell particles at 400°C, characterized by EDS analyzer and uses as filler in polymer composites. An experimental study was conducted to compare the erosive wear behavior of both raw and carbon black wood apple shell particles filled epoxy resin matrix composites. The effect of wood apple shell particles concentration with different impingement angles (30°,45°,60°and 90°) at constant impact velocity 48 m/sec on the erosion rate of composite has been analyzed. However, it is found that the carbon black particulates composite shows minimum wear as compared to raw particulate composite. It also shows semi ductile type failure and maximum erosion rate is observed at 60° impingement angle. Further, the erodent worn surface morphology is examined by using scanning electron microscope (SEM).

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Key words:wood apple shell; carbon black; wear; EDS; SEM

1. Introduction

Historically composite are old but in1960 it start capturing the attention of industries with the introduction of polymeric-based composites. Polymer based composite materials have been used widely in home appliances, construction, automotive industry, packaging application, aircraft engine blades due to their excellent specific mechanical and tribological properties for thousands of years by Guadagnoa et al. (2009), McIntyre et al. (2005) and Leman et al. (2008). In 1999, the construction sector was the world's second largest consumer of polymer composites representing 35% of the global market by Yan et al. (2000).

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In that period synthetic fibers like glass and aramid used as reinforcement in polymer composite. Synthetic fibers provide advantages of high stiffness and strength compared to conventional construction materials, i.e. wood, concrete and steel. In spite of these advantages, synthetic fibers have a tendency to decline because of their high-initial costs and pollution generated during the production and recycling.

In recent period bio fibers have attracted their attention of researchers because of their advantages over other established materials. These bio fibers are fully biodegradable, environmentally friendly, renewable, abundantly available, high stiffness, cheap, low density and high degree of flexibility during processing. Literatures survey reveals that various attempts made to develop polymer composites modified with various fillers (such as jute, banana, bamboo, coconut, silica, carbon black, Al_2O_3, $CaSiO_3$, etc.) in other to improve the performance of this matrix by Murali Mohan et al. (2007), Wetzel et al. (2003), Dandekar et al. (2005) and He et al. (2009). Xing and Li (2004) investigated the effect of silica particle size on the wear behavior of epoxy composites at low levels of filler content. In that study, it was proved that the smaller sized particles seemed to be more effective in improving the wear resistance. Recently, conductive polymer composites obtained by filling polymer matrices with various carbon blacks were reported by Krzesinska et al. (2008).

Particulate fillers of which carbon black is a notable example are widely used as reinforcing in polymer industries for advanced application by Zhang et al. (2008). Carbon blacks are produced from the agricultural and forestry waste materials but over the last century those carbon black were obtained from thermal cracking of natural gas, furnace black which is produced by incomplete combustion of oil feed stocks. The production of carbon black is relatively very expensive; therefore researchers found the alternative source i.e. renewable resources such as agricultural waste from which carbon black can be prepared. According to their investigation carbon black can be prepared by the pyrolysis of coal, wood, coconut shell, oil palm shell and other lignocellulosic materials because they are carbonaceous in nature and reach in organic materials. This biomass can be converted into carbon black thereby reducing unwanted, low-value agricultural residues and underutilized crop into useful, high-value materials by Abdul Khalil (2007). Carbon black is widely used for adsorption of pollutants from gaseous and liquid streams, for recovery of solvents, due to their high adsorptive capacities, porous size and relatively high mechanical strength. It is also used for coating, ink and inkjet application. Carbon materials provide excellent properties for a large spectrum of industrial applications by Adinata (2007). From carbon we obtain the strongest fibers (carbon fibers), one of the best solid lubricants (graphite), one of the best electrically conducting materials (graphite electrodes), the best structural material for high temperature tribological application (carbon–carbon composites). Among the various bio fibers wood apple shell is also a carbonaceous fiber. Still there is no work has been so far done on the chemical modification and analysis of wear behavior of polymer composite incorporating wood apple shell particulates. Some researchers like G.anusha (2011) and Ahmad (2011) used wood apple shell particulates as an absorbent for the removal of iron or Congo red dye from waste water using wood apple shell carbon.

The objective of this paper is to fabricate a new set of carbon black particulate filled polymer composite using bio waste wood apple shell. The effect of solid particle erosion wear and morphological behavior of the composite was investigated. In addition, the wood apple shell particles were also characterized by EDS analyzer to find out the elemental composition present in the wood apple shell particles. Some results, previously published by Adinata et al. (2007), Dandekar et al. (2005) and Abdul Khalil et al. (2007), were very encouraging and point towards the possibilities of structural and thermal applications of these composites.

2. Materials and methods

2.1. Epoxy resin

Epoxy LY556 (liquid diglycidyl ether of biphenol -A (DGEB-A) resin is used for this experimental study. It has been used extensively due to superior strength, excellent adhesion, good chemical resistance and excellent performance at elevated temperatures. Epoxy resin having density 1.2 g/cm^3, equivalent weight and viscosity is 182-192(gr/eq) and 11000-14000 MPa.s at 25°C.

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