Synthesis and Erosion Wear Analysis of Short Bamboo Fiber Reinforced Epoxy Composites Filled with Ceramic Fillers

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ABSTRACT

Hybrid natural fiber reinforced composites with ceramic fillers has been fabricated. Two ceramic fillers (Alumina and Silicon Carbide) have been used for the synthesis of composites and the samples have been fabricated with hand layup technique. 10% and 20% weight percentage of filler materials have been used for the different sets of composite samples. Erosion wear analysis of these composite samples has been carried out at different impingement angles (30, 45, 60, 75, and 90) with varying impact velocities (48 m/s, 70 m/s, 82 m/s, and 109 m/s) and with varying erodent size (108, 125, 150, 180µm). Results for the composites with and without filler have been compared. It has been observed that composites filled with particulate filler shows improvement in wear resistance properties as compared to composites without filler. Among the two fillers, Al2O3 has shown better resistance as compared to silicon carbide. A scanning electron microscope has been used to study the morphology of eroded surfaces and the mode of material removal.

KEYWORDS

Alumina, Ceramic Fillers, Composites, Erosion Wear, Erosion, Silicon Carbide

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1. INTRODUCTION

Polymers and related composites have a lot of application in structural components of buildings due to their excellent properties. They offer benefits of easy processing and freedom in designing and shaping. Polymer composites also find a lot of applications in aircraft products, petroleum industry and outer space devices. However, in all of these applications, an important parameter is the solid particle erosion behavior of a material. Materials are operated in sandy environments in these materials, where the possibility of surface erosion is very much high (Tsang, 1986; Pool, 1986; Smeltzer, 1970). Solid particle erosion-wear is mode of material failure, which refers to the loss of material due to impact of solid particles at high velocity and at different angles. The erosion rates of polymer composites are considerably higher than metal. It is also well-known that the erosion rate of polymer composites is even higher than that of neat polymers (Hanger, 1995). So, in order to minimize these problems, third phase reinforcement like micro or nano size particulate fillers are incorporated. Incorporation of Particulate fillers enhance the properties of fiber-reinforced composites (Wang, 2011). This has been supported by many researchers (Pukanszky, 1995; Abrahamson, 1961; Rothon, 1997; Jang, 1994; Acosta, 1986). Enhancement of Mechanical properties and erosion wear behavior of fiber-reinforced composite filled with conventional fillers (like alumina and SiC) and industrial waste ceramic fillers (like fly ash, red mud, copperslag, etc.) have been investigated by various researchers. It is reported that fillers increase the wear resistance over neat polymer reinforced composite without filler (Jena, 2016; Latha, 2017; Jeena, 2012). Tewari et al. (2003) have studied the effect of impact velocities and impact angles on solid particle erosion of short fiber reinforced poly-aryl-etherketones composites. A study by Harsha et al. (2003) on the influence of impingement angle and fiber orientations concludes that unidirectional carbon and glass fiber-reinforced epoxy composites show semi-ductile erosion behavior, with the maximum erosion rate occurring at 60-degree impingement angle. Arjula and Harsha have studied the erosion mechanism and erosion behavior of various polymers and their composites (Arjula & Harsha, 2006) Detailed review on the solid particle erosion wear characteristics of fiber and particulate filled polymer composites has been done by Patnaik et al. (2008). Biswas et al. (2009, 2014) studied the effect of various parameters on the mechanical and erosion wear behavior of glass- and bamboo fiber-reinforced epoxy composites filled with different particulate fillers.

Silicon carbide has low density and good strength at elevated temperature, so it can be used as good structural material at high temperature. So, silicon carbide is considered as a potential material for many high temperature engineering applications (Sieber, 2000; Qian, 2006; Griel, 2002). Aluminum oxide (Al₂O₃) usually named as ‘alumina’ is very effective and widely used material in many structural applications. Al₂O₃ has very good chemical resistance, good insulator properties, good tribological properties, good mechanical properties. Similarly, silicon carbide (SiC) is another ceramic material has the potential to be used as filler in varied polymer matrices. This is an excellent abrasive, employed in grinding wheels and different abrasive product
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