Solid Particle Erosive Wear Behavior of Glass Mat Reinforced PPS Composites: Influence of Erodent Particle Size, Pressure, Particle Impingement Angle, and Velocity

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ABSTRACT: This study investigates solid particle erosive wear behavior of glass mat reinforced polyphenylene sulfide (PPS) matrix composites under...
SOLID PARTICLE EROSIVE WEAR BEHAVIOR OF GLASS MAT REINFORCED PPS

various test parameters. PPS composite was manufactured by using the compression-molding process. Composite samples were eroded in a specially designed sandblasting system employing various parameters, and variation of the erosion rate was investigated. Samples were eroded at different erosion times, particle impingement angles, and under various pressures by using three different sizes of alumina particles. Impingement velocities of erodent particles were measured by using the double disk method. The results are also discussed regarding impingement velocity of the erodent particles. Glass mat reinforced PPS composites exhibited semiductile erosion behavior by showing a maximum erosion rate at 30° and 45° impingement angles. The erosion rate of the composite was increased with augmentation in erosion time, velocity, pressure, and particle size. Maximum erosion was observed when the composite was eroded after 10 s at 45° impingement angle under 4 bar pressure by using 60 mesh size erodent particles. The morphology of eroded surfaces was examined by using a scanning electron microscope, and possible wear mechanisms were discussed. © 2012 Wiley Periodicals, Inc. Adv Polym Techn 00: 1–13, 2012; View this article online at wileyonlinelibrary.com. DOI 10.1002/adv.21286

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Introduction

Solid particle erosion is a process of progressive removal of material from a target surface due to the repeated impact of solid particles. It is a useful process in certain cases, as in sandblasting and high-speed abrasive water jet cutting. However, solid particle erosion generally leads to negative effects, such as wear of components, surface roughening and degradation, macroscopic scooping appearance, and reduction in the functional life of the structure. These side effects can be considered as serious problems, because they are responsible for many failures in engineering applications. Space and aircraft applications such as steam and jet turbines, rotor blades of helicopters, pipelines and valves carrying particulate matter, power plant applications such as fluidized bed combustion systems, and automobile and marine applications are strongly subjected to solid particle erosion. Over the past decades, fiber-reinforced thermoplastic matrix composites have been replacing traditional metal alloys, particularly in aircraft applications. Fiber-reinforced thermoplastic matrix composite structural parts used in aircraft are strongly exposed to dusty environmental conditions such as volcanic fly ash, which cause solid particle erosion of composite materials. In Fig. 1, the distribution of the damage rate on the airframe of a commercial airliner due to solid particle impact is shown.

The airframe regions shown in Fig. 1 can be seriously damaged by solid particle erosion. In particular, the effect of solid particles like volcanic fly ash and its synergy can adversely affect the

FIGURE 1. The distribution of the damage rate on the airframe of a commercial airliner due to solid particle impact. The larger dots correspond to objects with medium speed. The smaller dots correspond to impact sites for lower speed objects, and the hatched region exhibits the impact site where high-speed impacts frequently occur.