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Technical Report

Effect of sliding distance on the wear and friction behavior of as cast and heat-treated Al–SiCp composites

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ABSTRACT

The present investigation aims to evaluate the effect of sliding distance on the wear and friction behavior of as cast and heat-treated Al–SiCp composites using pin-on-disc wear testing machine, giving emphasis on the parameters such as wear rate and coefficient of friction as a function of sliding distance (0–5000 m) at different applied pressures of 0.2, 0.6, 1.0 and 1.4 MPa, and at a fixed sliding speed of 3.35 m/s. Characterizing the alloy and composites in terms of microstructure, X-ray diffraction analysis, microhardness and wear surface analysis. The results revealed that the heat-treated composite exhibited superior wear properties than the base alloy, while the coefficient of friction followed an opposite trend. Moreover, the wear rate of the composite is noted to be invariant to the sliding distance and increased with applied pressures. Microstructure of composite shows fairly uniform distribution of SiC particles in the metallic matrix. The hardness value of heat-treated composite increased 20–30% by addition of SiC particles to the alloy, intermetallic phases like Al_2Mg_3 and Al_2CuMg, etc., were obtained from X-ray analysis. The wear mechanism of the investigated materials was studied through worn surfaces examination of the developed wear tracks.

1. Introduction

Aluminum matrix composites (AMCs) are becoming potential engineering materials offering excellent combination of properties such as high specific strength, high specific stiffness, electrical and thermal conductivities, low coefficient of thermal expansion, better wear and seizure resistance [1,2]. Because of their excellent combination of properties, AMCs have been emerged as advanced materials for several applications in automobile, aerospace, defense and other engineering sectors [2–6]. Indeed, these promising new materials have found wide range of application in automobile industries in the recent years in order to improve the fuel efficiency. Out of different automobile components, AMCs have been found to be a more promising material, especially in brake drum, cylinder blocks, cylinder liners, drive shafts etc. [1–6]. In aerospace industries, Al composites are used essentially in structural applications such as helicopter parts (parts of the body, support for rotor plates, drive shafts), rotor vanes in compressors and in aero-engines [5]. The performance of these components is based primarily on their wear and friction characteristics. In recent times, attention is being paid to the use of high strength Al–Cu–Mg alloys for structural applications in aerospace and general engineering sectors etc. [5,6]. Attempts have been made to examine the effect of sliding distance on the wear and friction properties of as cast and heat-treated Al–SiCp composites.

Das et al. [7] examined the heat-treated composites were found to possess superior wear properties (wear rate, seizure resistance and P-V limits) as compared with those of die-cast composites and matrix alloys. Lin et al. [8] reported that the tribological behavior of the composites in the T6 heat-treated condition is better than in the annealed condition or than that of the unreinforced alloy. Hassan et al. [9] demonstrated that the wear loss of the copper containing alloys was less than that for the copper free alloys. It was observed that the volume losses in wear test of Al–Mg–Cu alloy decrease continuously up to 5%. Also it was found that the silicon carbide particles play a significant role in improving wear resistance of the Al–Mg–Cu alloying system. Singh et al. [10] studied the composite exhibited lower wear rate than that of the matrix alloy. Increasing applied load increased the wear rate. In the case of the composite, the wear rate decreased with speed except at higher pressures at the maximum speed; the trend reversed in the latter case. On the contrary, the matrix alloy exhibited minimum wear rate at the intermediate test speed. Seizure pressure of the composite was significantly higher than that of the matrix alloy, while temperature rise near the contacting surfaces and the coefficient of friction followed an opposite trend. Acilar and Gul [11] observed that the volumetric wear rate increased with increasing sliding distance and increasing applied load. Oxidation

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