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Technical Report

Abrasive wear behaviour of hard powders filled glass fabric–epoxy hybrid composites

N. Mohan, S. Natarajan *, S.P. KumareshBabu

Department of Metallurgical and Materials Engineering, National Institute of Technology, Tiruchirappalli 620 015, India

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ABSTRACT

The effect of incorporation of tungsten carbide (WC) and tantalum niobium carbide (Ta/NbC) powders on three-body abrasive wear behaviour in glass fabric–epoxy (G–E) composites was investigated and findings are analysed. A vacuum assisted resin transfer moulding (VARTM) technique was employed to obtain a series of G–E composites containing different fillers (WC and WC + Ta/NbC). Dry sand rubber wheel abrasion test was carried out at 200 rpm speed. The effect of different loads (22 and 32 N) and abrading distances (from 135 to 540 m) on the performance of the wear resistance were measured. The wear volume loss of the composites was found increasing with the increase in abrading distances and under the same conditions the specific wear rate decreases. The hard powders filled G–E composite systems exhibit lower wear volume loss and lower specific wear rate as compared to unfilled G–E composite system. The features of worn surfaces of the specimen were evaluated at higher and lower abrading distances at load of 32 N were using scanning electron microscope (SEM) and results indicate more severe damage to matrix and glass fiber in unfilled composite system as compared to hard powder filled composites.

1. Introduction

Polymers and their composites are extensively used in tribological sectors because of light weight, excellent strength to weight ratios, resistance to corrosion, self lubricating properties, better coefficient of friction and better wear resistance [1]. Thermoset epoxy resins are extensively studied as matrix materials for composite structures as well as adhesives for aerospace, aviation and hydrospace applications because they exhibit low shrinkage, higher mechanical properties, easy fabrication, excellent chemical and moisture resistance, good wettability and good electrical characteristics. These materials are widely used for a variety of engineering applications in automotive, marine and aerospace. The importance of tribological properties and wear behaviour of polymeric composites were studied in detailed by Kishore et al. [2]. The improvement of the tribological properties of a polymer with the incorporation of fibers/fillers is well known and it showed both positive and negative results on the tribological properties of a polymer [1,3]. Three-body abrasive wear is caused by interactions of hard asperities (hard debris or foreign particles trapped between the polymer and mating surface) on one surface move across a softer surface under load, it penetrate and remove material from the softer surface and also leave grooves on the softer surfaces that may further increase or decrease the wear rate by several orders [4]. Three-body abrasive wear is often has considerable practical importance, for example in coal handling equipments in power plants, gear pumps handling industrial fluids and agricultural machine components, sleeve bearing and bushes operating in abrasive environment, lower sleeve bearing in vertical sewage pumps, vehicle spring bushes, marine stern tube bearings, chain wear strips, rope sleeve bearings, etc. [5,6]. Suresha and Chandramohan [7] showed that silicon carbide loaded glass fabric–vinyl ester composite gives better abrasive wear performance as compared to graphite filled composite system. Crivelli Visconti et al. [8] studied a 6 vol.% of silica (SiO_2) and tungsten carbide (WC) filler filled glass fabric reinforced with epoxy matrix composites and they found that tungsten carbide filled G–E composite shows excellent wear resistance. Commonly used filler materials in fiber reinforced polymer composites are graphite, molybdenum disulfide, tungsten carbide and silicon carbide. Graphite (Gr) and molybdenum disulfide (MoS_2) possess self-lubrication properties and they are widely used in bearing liner applications. Silicon carbide (SiC) has been extensively used in abrasive machining processes such as grinding, honing, water-jet cutting and sand blasting due to its high hardness. The SiC and WC in epoxy imparts good abrasion resistance and strength [7–9,12]. Keeping the above aspects in view, it is clear that there is a lot of scope for the study of abrasive wear behaviour of polymer matrix composites. The present study was focus on the preparation of glass fabric reinforced-epoxy composites reinforced with tungsten carbide (WC) and tantalum niobium carbide (Ta/NbC) as fillers in powder form and to investigate the influence of these hard powders on three-body abrasive wear behaviour.

* Corresponding author. Tel.: +91 431 2503000; fax: +91 431 2500133.
E-mail address: drsnatarajan.nitt@gmail.com (S. Natarajan).

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