Journal of Manufacturing Engineering, September 2015, Vol. 10, Issue. 4, pp 220-222

EFFECT OF E-GLASS FIBER LOADING ON WEAR BEHAVIOUR OF POLYESTER COMPOSITES UNDER DRY CONDITION

Satheesh Raja R[1] and Manisekar K[2]

[1]Department of Mechanical Engineering, PET Engineering College, Vallioor – 627 117, Tamilnadu, India
[2]Centre for Manufacturing Sciences, National Engineering College, Kovilpatti - 628 503, Tamilnadu, India

ABSTRACT

Wear behaviour of E-glass reinforced polyester composites with different weight percentages of resin and fiber have been studied using pin-on-disk method. The wear tests were conducted for the different normal loading of 5N, 10N and 15N with the varying sliding distances of 500m, 1000m and 1500m. The test results indicate that the 70 wt % of resin and 30 wt % of fiber increases the wear resistance of the composites. The factors affecting the wear behaviour of composites such as weight percentage of resin, fiber and the bonding strength between them were thoroughly investigated. Wear mechanism of the composites were studied by analysing the worn surface morphology of the specimens using field emission scanning electron microscopy (FESEM) at high resolution.

Keywords: *Polymer-matrix composite, wear, Glass Fiber, FESEM.*

1. Introduction

Polymer matrix composites are emerging trends in the tribological components such as bearings, rollers, gears, cams, wheels, transmission belts, grinding mills and clutches where their self lubricating properties are exploited to avoid the need for lubrication with its attendant problems of contamination [1-3]. E-Glass fibers are the most widely used to reinforce polymers due to their good mechanical properties and low cost. Polymer composites reinforced with these fibres are usually one to four times stronger and stiffer than their unfilled matrices [4-6]. The role of polymer as a matrix in a fibre-reinforced composite is, to transfer stresses between the fibres, to provide a barrier against an adverse environment and to protect the surface of the fibres from mechanical abrasion [7-9]. Glass fiber reinforced polymer with thermoset polyester resin is an attractive material that is economically desired. The applied load, sliding speed, weight percentage of resin and fiber play significant role on the wear behavior of polymer matrix composites [10]. Thus the aim of the present work is to study the effect of E-glass fiber loading on wear behaviour of polyester composites under dry condition.

2. Experimental Details

Polyester resin was used as matrix material and the E-glass fiber as reinforcement material in the composites were supplied by Leo enterprises, Nagercoil, India. The catalyst and the accelerator used in the fabrication of composite specimens are Methyl ethyl ketone peroxide (MEKP) and cobalt napthanate. Poly vinyl alchol (PVA) was used as releasing agent. The hand layup technique is used for making of the composite specimens. In this, the required dimension of E-glass fiber mat was placed one above the other. In between these fiber layers the polyester resin mix consists of catalyst and accelerator are well spread in the mould. This process was repeated to obtain the required thickness of 3mm. The air bubbles are removed by using rolling process and also to obtain the uniform specimen thickness. The fabrication mould assembly is placed in the compression moulding machine at required pressure and cured at room temperature for 24 hours. Specimens of dimensions 10 mm x10 mm x 3mm were cut using diamond cutter for characterizing the wear properties.

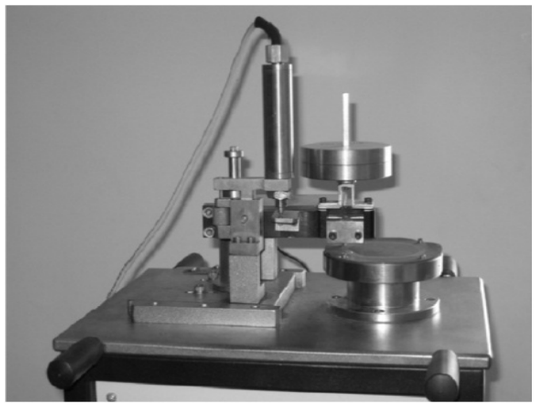

Fig.1 Pin-on-disc apparatus

**Corresponding Author - E- mail: nanosatheesh@gmail.com*

The wear behaviour of the prepared composite specimens was observed using a pin-on-disc wear testing apparatus as per ASTM G 99 shown in Fig 1. The test specimens of required size were attached with 6 mm diameter pin using adhesive. The composite specimen and the steel disc surface are cleaned using acetone before the wear test. Here the specimen is kept stationary and the disc is rotating while the normal load is applied. The wear test was performed for three different normal loading of 5, 10 and 15 N under three sliding distances of 500, 1000 and 1500 m. The weight of the specimen before and after the test was noted with an accuracy of ±0.01mg using electronic balance.

3. Results and Discussion

The variation of wear loss in the composite specimens with applied loads 5, 10 and 15 N and sliding distances of 500, 1000 and 1500 m under dry condition are shown in Fig 2 (a-c).

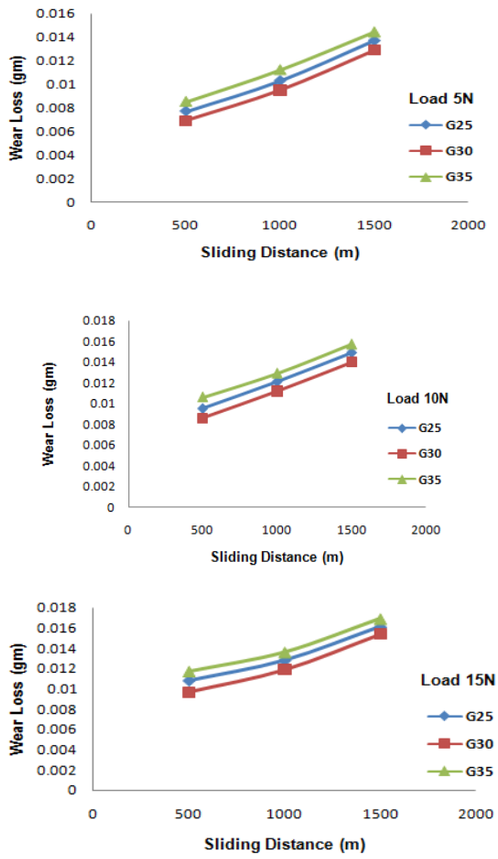

Fig.2 Variation in wear loss with applied normal load a) 5 N b) 10 N c) 15 N

From the obtained results, it can be seen that the wear loss is increasing with the increasing of load value from 5 N to 15 N. It is also evident from the plot that the wear loss of the composites increases with the increase in sliding distance. The increase in the sliding distance increases the temperature at the friction surface and affect the tribological properties of the composites which results in serious wear loss. Thus, the wear loss increases with the sliding distance for given load and composite material conditions.

It is clear from the figs 2 (a-c) that the composites with 30 wt% of E-glass have fiber improved wear resistance properties. But at 25 and 35 wt% of E-glass fiber reinforced composites, the wear resistance decreases. This is mainly due to the weak interfacial bonding between the fiber and resin in the composites.

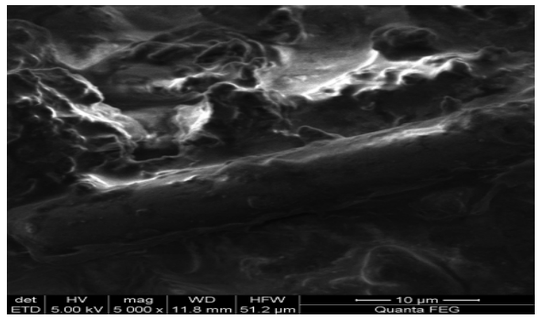

Fig 3. SEM image of 30 wt% fiber

To correlate the wear data effectively, scanning electron photomicrographs of worn surfaces of 30 wt% of E-glass reinforced composite sample is shown in Figure 3. The wear performance of the fiber reinforced polymer composites are governed mainly by the process of fiber thinning, fiber breaking and fiber peeling off under dry sliding. The fiber removal plays an important role in the wear mechanism. SEM image showed that the matrix is well bonded with glass fiber and also it protects the fiber from the damage. So the wear loss is less in 30 wt% fiber content composites when compared with the other wt % of fibers in the composites.

4. Conclusions

From the observations made in the study, the following conclusions are drawn.

i. Wear loss increases with the increase in applied normal load and sliding distance.
ii. The incorporation of E-glass fiber in the polyester resin can improve the wear resistance of the composites. The optimum wear resistance property was found at the fiber content of 30 wt%.

iii. SEM observations in worn surface of the composites with 25 wt% and 35 wt% of E-glass fiber exhibits severe matrix damage, and separation fiber from the matrix. But at 30 wt% of fiber content reinforced composites, the better fiber and matrix interfacial bonding is observed.

References

1. *Chittaranjan Deo Acharya S K (2010), "Effects of fiber content on abrasive wear of Camara fiber reinforced polymer matrix composite", Indian Journal of Engineering & Materials Sciences, Vol. 17, 219-223.*

2. *Sudheer M Ravikantha Prabhu Raju K Thirumaleshwara Bhat (2013),"Modeling and Analysis for Wear Performance in Dry Sliding of Epoxy/Glass/PTW Composites Using Full Factorial Techniques", ISRN Tribology, Vol. 1 - 11.*

3. *Kukureka S N Hooke C J Rao M Liao P Chen Y K (1999), "The effect of fibre reinforcement on the friction and wear of polyamide 66 under dry rolling–sliding contact", Tribology International, Vol. 32, 107–116.*

4. *Suresha B Chandramohan G Sadananda Rao P R SampathKumaran P Seetharamu S (2006), "Vartha Venkateswarlu. Friction and slide wear characteristics of glass-epoxy and glass-epoxy filled with SiCp composites", Indian Journal of Engineering & Materials Sciences, Vol. 13, 535-541.*

5. *Chowdhury M A Nuruzzaman D M Roy B K Samad S Sarker R Rezwan H M (2013), "Experimental Investigation of friction Co efficient and Wear Rate of Composite Materials Sliding Against Smooth and Rough Mild Steel Counterfaces", Tribology in Industry, Vol. 35, 286-296.*

6. *Chauhan S R Bharti Gaur Kali Dass (2011), "Effect of Fiber Loading on Mechanical Properties, Friction and Wear Behaviour of Vinylester Composites under Dry and Water Lubricated Conditions", International Journal of Material Science, Vol. 1,1-8.*

7. *Zhenyu Jiang Lada Antonova Gyurova Alois K Schlarb Klaus Friedrich Zhong Zhang (2008), "Study on friction and wear behavior of polyphenylene sulfide composites reinforced by short carbon fibers and sub-micro TiO2 particles", Composites Science and Technology, Vol. 68, 734–742.*

8. *Suresha G Chandramohan P Sampathkumaran Seetharamu S and Vynatheya S (2006), "Friction and Wear Characteristics of Carbon-Epoxy and Glass-Epoxy Woven Roving Fiber Composites," Journal of Reinforced Plastics and Composites, Vol. 25, No. 7, 771-782.*

9. *J K Lancaster (1972), "Friction and Wear in Polymer Science," In: Jenkins A D, A Material Science Hand Book, North Holland, Amsterdam.*

10. *Evans D C and Lancaster J K (1979), "The Wear of Polymers," In: Scott D, Treatise on Materials Science and Technology, Academic Press, New York, Vol. 13, 85-1.*

