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EFFECT OF FILLER ON THREE BODY ABRASIVE WEAR BEHAVIOUR OF CARBON FIBER REINFORCED EPOXY COMPOSITES

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ABSTRACT

In this study, an experimental investigation was carried out to study the effect of MoS_2 filled Carbon epoxy composites in three –body abrasive wear situations. Three-body abrasive wear studies were carried out using a rubber wheel abrasion test (RWAT) rig at 200 rpm. Silica sand particles of size ranging from 212-250 μm were used as abrasives. The wear loss & wear rate changes significantly with the addition of MoS_2. It observed that the inclusion of MoS_2 filler enhances the abrasion resistance of the Carbon-Epoxy composites.

Keywords: Three-body abrasive wear; carbon-Epoxy composites, wear loss, wear rate.

1. INTRODUCTION:

Fiber reinforced polymer composites (F.R.P.C), due to their combination of high specific strength and specific modulus are widely used for structural, aerospace and automobiles sector. These two main characteristics make these materials very useful compared to conventional material. The commonly used polymer matrices include polytetra fluoro ethylene (PTFE), polyether ether kethone (PEEK), Vinyester , unsaturated ,epoxy ,etc. The polymer and their composites find very useful applications in automotive components such as gears ,cams ,wheels ,brakes ,clutches ,bearings and also in other engineering applications like conveyor aids ,chute liners , power ,mining ,agriculture and other allied field.

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1.1 Abrasion Wear Mechanism

Abrasive wear can be defined as one in which hard asperities on one body, moving across a softer body under some load, penetrate and remove material from the surface of the softer body, leaving a groove. These hard 'asperities' may in fact be small discrete particles or may be big discrete particles on a large body. Abrasive wear can occur as two body abrasion, three body abrasion, or a combination. To understand the law stress abrasive wear mechanism of the metallic or ceramic counterpart needed to be addressed. it is therefore necessary to understand the basic phenomenon of three body abrasion. Several researchers have reported on the abrasive wear behaviour of FRPCs.

2. EXPERIMENTAL DETAILS:

2.1 Materials and Methods

Table: 1 Composition of Plates Fabricated

SL	Composites	Reinforcement (%)	Matrix%)	Filler%
1	CF/Epoxy	40	60	0
2	CF/Epoxy/Filler	35	60	5
3	CF/Epoxy/Filler	32	60	8

2.1.1 Specimen Preparation

The steps involved in preparation of carbon fiber reinforced epoxy composites laminates by hand layup technique is as follows:

Step 1: The rectangular box of dimension 100mm×170mm is cleaned with soft brush using acetone to remove the dust. A layer of wax is coated on the cleaned surface for the easy removal of the laminate after curing. Carbon fiber strand is cut to fit rectangular box.

Step 2: The epoxy resin is weighed and is poured in to a bowl. Hardener K12, which is 2%-6% that of the weight of epoxy resin is added to the bowl containing epoxy and stirred uniformly

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Step 3: The first layer of epoxy resin is coated on the wax on which a single strand of carbon fiber is placed. Again a layer of epoxy is coated on which the carbon fiber strands is placed. Same procedure is repeated until the desired thickness is obtained. Alternate layers of epoxy and carbon fiber are placed

Step 4: On the top most surface of the carbon fiber a flat plate of laminate with same dimensions is placed. The pressure is applied manually for the extra epoxy resin to squeeze out from sides of the laminates.

Step 5: The laminate is cured under light pressure for 2 hrs, followed by curing at room temperature for 24 hrs. By following the same procedure as said above composite material having filler composition of 5% and 8% is prepared. The wear behaviour of all the composite laminates are tested.

2.2 Abrasive Wear Studies

The schematic representation of rubber wheel set up is as shown in figure 1.

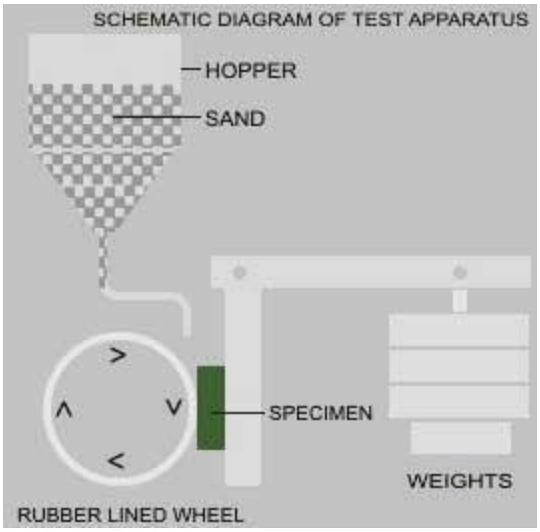

Fig1: Schematic representation of dry sand rubber wheel abrasion test rig

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The abrasive (SILICA SAND OF AFS 60 grade) was fed at the interface between the rotating rubber wheel (200 rpm) and the test sample measuring 75mmx25mmx3mm. The sample was cleaned (DRY) and its initial weight determined in a high precision digital balance (.1mg accuracy) before it was kept in the sample holder. The abrasives were introduced between the test specimens and rotating abrasive wheel composed of the chlorobutyl rubber tyre. The test specimen was pressed against the rotating wheel at a specimen load, applied by means of lever arm while a controlled flow of abrasive abraded the test surface. The rotation of the abrasive Wheel was such that its contact face moved in the direction of the sand flow. The pivot axis of the lever arm lies within a plane, which is approximately tangent to the rubber wheel surface and normal to the horizontal diameter along which the load is applied .At the end of the set test duration, the specimen was removed, thoroughly cleaned and again weighed (final weight). At least three test were performed and the average value were reported. The abrasive studies were carried out at three different load (11, 22 and 35N) at a constant sliding velocity. For varying abrading distance (300-1200 m varied in step of 300 m), sample were abraded for the appropriate time intervals. Weight loss measurements were made at regular test intervals using digital electronic balance. The wear was measured by loss in weight ,which was then converted into wear volume using measuring density data .Before and after wear testing ,sample were tested, sample were cleaned with acetone in an ultrasonic cleaner and then dried. The specific wear rate (Ks)was calculated from the equation

$$K_s\,(m^3/Nm)=\Delta V/L*D \qquad (1)$$

Where ‘ΔV’ is the volume loss in m^3, ‘L’ the load in Newton and‘d’ is the sliding distance in meters.

Fig2: Typical Appearance of wear scars of abraded composite specimen

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3. RESULTS AND DISCUSSION:

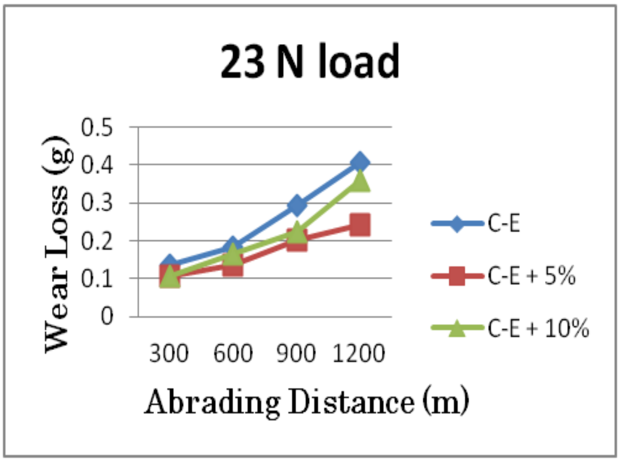

Fig 3: Wear Loss v/s Abrading distance

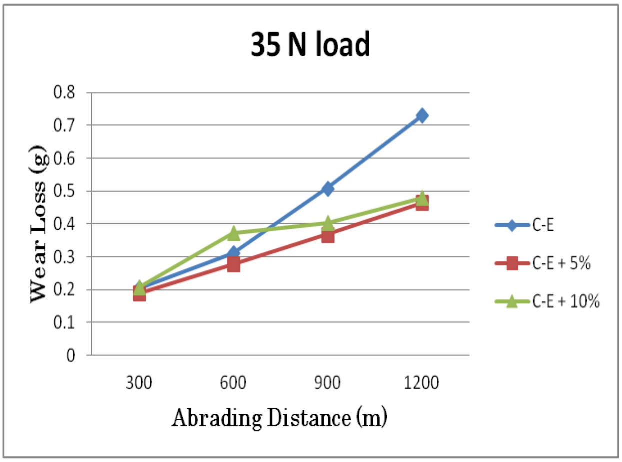

Fig4: Wear Loss v/s Abrading distance

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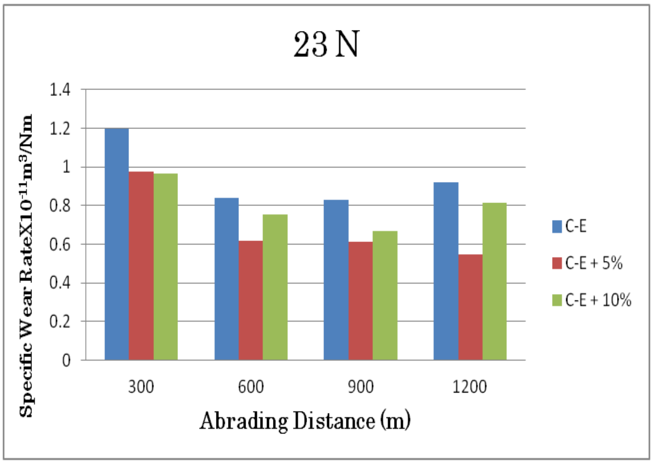

Fig5: Specific Wear Rate v/s Abrading Distance

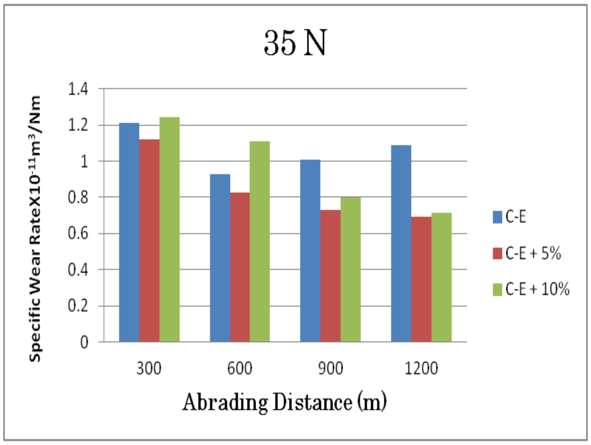

Fig6: Specific Wear Rate v/s Abrading Distance

Figure 3 and 4 shows the wear loss for different abrading distance of carbon epoxy fiber with and without filler for different loading conditions. It is clear from the figures that wear loss for carbon fiber-epoxy with 5% MoS_2 is less when compared to other materials. The graph was plotted under the condition of using dry sand as abrasive. The wear data reveal that the wear volume tends to

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increase near linearly with increasing abrading distance for the carbon fiber reinforced epoxy composite. The wear loss decreases with increase in filler loading.

In general, the type, size and concentration of filler play a major role in the abrasive wear behaviour of filler reinforced polymer composite

Figure 5 and 6 shows specific wear rate as a function of abrading distance for different loading conditions. It is evident from figure 5 that for a load of 23N, the wear rate is more in carbon epoxy composite without fillers when compared with carbon epoxy with fillers.

4. CONCLUSIONS:

The following are the salient observations were made from the above investigations.

- For all samples the wear loss increases with abrading distance
- The addition of MoS_2 filler improves the abrasion wear resistance of the carbon fiber reinforced epoxy composites.
- 5% MoS_2 filler by weight in carbon epoxy composites showed optimum performance under three body abrasive wear.

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