Abrasive Wear Behavior of Graphite Filled E-Glass Fibre Reinforced Polyester Composites

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Abstract - *In last decade there has been a significant increase in production of Polymer composites, which are taking place of conventional materials for use in different applications due to their excellent mechanical properties. Glass fibre reinforced polymers are widely used in automobile and aerospace industries for making lightweight equipment like dashboard back panels etc. The composite samples used for the study were developed by compression molding method and constituents were E-glass fibre as reinforcement, Polyester as resins and Methyl Ethyl Ketone Peroxide as a hardener. To enhance the self-lubricating property of the material different proportions of micro Graphite particles were added. Composite materials were developed in three different material concentration,) 15% 30% and nil. Developed composite samples were tested for self-lubricating properties at different loads using Ducom Two Body Abrasion Tester. The results state that the wear increased for all three samples as the load was increased, however, overall minimum wear was obtained for 15% filled sample.*

Key Words: E-Glass Fibre, Polyester, Graphite, Abrasive Wear, FRP.

1.INTRODUCTION

Composite materials consist of two or more constituents which when combined together show improved properties than individual materials [1–4]. The constituents may be present in separate phases. The most common fibre reinforced polymer composites are based on reinforcement; Glass Fibre embedded in a matrix of resin; polyester. The filler is also added sometimes to the mixture to get desired properties; in this case, Graphite powder was added to attain self-lubricating properties. Polyester matrix composites (PMC) not only have good specific mechanical strength but excellent thermal and tribological properties. These properties lead to the employment of polymeric composites for tribological purposes such as gears, brakes, clutches, bearings and transmission belts.

Graphite has several advantageous properties, like low friction, high-temperature stability and lower chemical reactivity. Due to these benefits, Graphite is employed as a filler material which reinforces the self-lubrication property of composite [5–10].

Abrasive wear occurs when a hard rough surface is rubbed against the softer surface. It depends on contacting environment and type of contact. The wear is broadly classified into two categories two-body abrasion and three body abrasion, but the former is more prevalent. In two-body abrasion material to material, contact occurs between two surfaces in which asperities of the harder surface cut through another material surface. While in three body abrasion foreign hard particles are stuck between two sliding surfaces which are free to move and roll. These foreign particles are responsible for wear [11–17, 17–19].

1.1 Composite Material

In the fabrication of samples, woven E-Glass fibre mat with a fibre diameter of 5-12μm and unsaturated polyester was used. Methyl-ethyl-ketone-peroxide (MEKP) was used as hardener which reduced the curing time and temperature. Graphite was filled in two different configurations of 15% and 30 %. Developed GRAPHITE filled and unfilled E-Glass-Polyester composite was tested for Tribological properties using Ducom Abrasive Wear Tester.

1.2 Fabrication of Samples

The first sample of the E-glass polyester reinforced composite was prepared by using a woven mat of 300×300 mm size by placing layer by layer of 10 mats with a layer of polyester resin, and 10% of methyl-ethyl-ketone-peroxide (MEKP) in between. The sample was cured in compression moulding machine at 140^{0}C and 15 bar pressure for one hour. Another two samples were prepared by following the similar steps but the resin contained 15% and 30% Graphite by weight to the resin.

1.3 Compression Molding Machine

Compression molding is a one of the well known oldest technique used to develop a variety of composite products. It is a closed die molding method where an adequate amount of heat and pressure is applied to the process; during this process matched metal moulds are used to fabricate the composite product. In compressor molder one of the plates is stationary and other is movable. Reinforcement and matrix are placed within the mould; heat and pressure are applied as per the requirement of the composite. Generally, hydraulic mechanism is employed for pressure application. Compression molding is a method suitable for molding complex, high-strength fibre reinforcements. It is one of the lowest cost molding methods compared with transfer molding and injection molding [20, 21].

Figure 1 Compression Molding machine

2. TEST APPARATUS AND PROCEDURE

Two body abrasion testing machine is used to test the abrasion wear of the material. In abrasion testing apparatus the testing specimen is allowed to slide over the rotating circular wheel embedded with the abrasive material over the periphery of the circular wheel, due to the relative motion between the testing specimen and the rotating circular wheel causes the removal of the material. Testing samples cut from all the three composite of size (70 ×25) to test the abrasion wear behaviour of all three composite. The composite was allowed to slide (to and fro motion) over the abrasion material at with 5mm/sec velocity at different loading condition between the samples and the abrasive material, all the samples were tested with speed of 60 rpm at the 400 cycles and at different loads (5N, 10N, 15N, 20N). The weight loss due to the abrasion wear is recorded using the weighing machine, the difference in the weight results in the rate of abrasion wear. Weighing the initial and final weight of the test specimen gives the result of abrasion wear rate of the test specimen.

3. RESULTS AND DISCUSSIONS

An experimental test was done on the Abrasive wear tester at various test parameters, which were following as in tables. In test grade, abrasive paper was used to investigate the increased tribological properties of developed samples.

- Sample 1- Unfilled – Base sample (E-glass fibre + polyester)
- Sample 2- 15% filled – Base sample + 10% GRAPHITE of polyester
- Sample 3-30% filled – Base sample + 20% GRAPHITE of polyester

The number of cycles is kept fixed at 400, while the amount of force applied is varied by changing the plates on dead weight column and adjusting till screen shows desired load output. The difference in weight of the sample before and after the test provides the amount of wear.

Table 1 Wear Evaluation Table

S No.	Sample No.	Load(N)	Initial Weight (gm)	Final Weight (gm)	Weight Loss (gm)
1	1	5	11.02	10.952	0.068
2	1	10	11.235	11.122	0.114
3	1	15	10.95	10.81	0.14
4	1	20	11.122	10.956	0.166
5	2	5	16.388	16.35	0.038
6	2	10	15.812	15.754	0.058
7	2	15	16.35	16.27	0.08
8	2	20	15.759	15.673	0.086
9	3	5	14.09	14.04	0.05
10	3	10	13.794	13.714	0.08
11	3	15	14.04	13.93	0.11
12	3	20	13.714	13.6	0.144

The result states that sample 1 shows higher wear than sample 2 and 3 thus it can be deduced that by filling of Graphite particles self-lubricating properties were enhanced.

However, the wear reduction is more for 15% sample as compared to 30% filled composite.

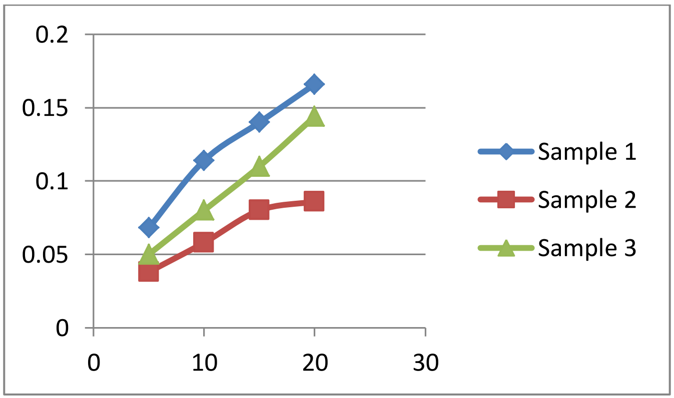

Figure 2 Abrasion wear versus Load

4. CONCLUSIONS

The following conclusions are drawn from the above investigation-

Reinforcing of Graphite filler contributed in reducing friction and exhibited better wear resistance properties.

- 15% filled composite exhibits higher resistance to abrasive wear as compared to 20% filled composite and unfilled polyester composite.

- As the load increases from 5N to 25N, the wear of all samples also increases.

- The Graphite filled composite shows the less wear than unfilled composite due to the self-lubricating property of GRAPHITE. GRAPHITE forms the strong bonding with the matrix

An important observation has been obtained from the experimental results that increased in Graphite percentage in composite composition results in increasing of wear. It has been observed that 30% filled composite exhibits higher wear than 15% filled composite. Therefore to obtain the better resistance to wear Graphite filler inclusion into composite should be inappropriate percentage ratio.

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