# Abrasive Wear Behaviour of PTFE Filled E-Glass Fiber Reinforced Polyester Composites

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**Abstract -** *Polymer composites are replacing the conventional materials for use in different applications due to their excellent corrosion resistant and good mechanical properties. Application of composite, where abrasive wear takes place. The composite were developed by compression moulding method and constituents were E-glass fiber, Polyester resins, Hardener (Methyl Ethyl Ketone Peroxide) were used 10:1 proportion to set the material. To enhance develop the self-lubricating property in material by addition of solid lubricant (PTFE) in various different proportion as filler material. Composite materials were developed with and without addition of filler material in different proportion. Developed composite materials samples were experimentally investigated for self-lubricating properties and analyze the effect of solid lubricant filler addition through Ducom abrasion were test. Experimental results were showed that 10% solid lubricant filled sample least wear out as in comparison of 20% filled and unfilled sample.*

***Key Words***: **E-Glass Fiber, Polyester, PTFE (polytetrafluoroethylene), Abrasive Wear, FRP Composite.**

## 1. INTRODUCTION

Composite material made of more than one component material. The polymer composites are combinations or compositions that comprise two or more materials as separate phases, at least one of which is a polymer. The most common fiber reinforced polymer composites are based on glass fibers embedded in a matrix of polyester resin [1]. Glass Reinforced Plastic (GRP) is an industrial term that denotes one of the composite materials, which is called glass fiber reinforced plastics. The GRP is used to control corrosion problems in oil fields, marine applications, chemicals and industrial plants [2]. Unsaturated polyesters are important matrix resins used for glass fiber reinforced composites/plastics. Polyester matrix composites (PMC) have good specific strength, high thermal conductivity and low coefficient of thermal expansion at lower temperatures. These beneficial parameters lead to the employment of polymeric composites in tribological purposes such as gears, brakes, clutches, bearings and transmission belts. [3].

Fillers are used to change and improve the physical and chemical properties of composite. PTFE is widely used as bearing material which is self-lubricating and subjects to lower coefficient of friction [4]. PTFE has many advantageous properties, such as low friction, high temperature capability and high chemical inertness. Due to this advantages and significant properties, PTFE is used as filler material which enhances the self-lubrication property of composite. Abrasive wear test has been done for the analysis of effect of filler material as well as self-lubrication properties.

Abrasive wear can be defined as wear in which hard asperities on one body, moving across a softer body under some load, penetrate and remove material from the softer body, leaving a groove [5]. Polymer composites undergo abrasive wear in most of the situations like earth moving equipment's, pipelines, rock drilling and ore crushers etc. Two-body abrasive wear is caused by embedded hard particles forced against and moving along solid surfaces.

### 1.1 Composite Material

In development of material woven E-Glass fiber mat with fiber diameter of 5-12μm and unsaturated polyester matrix is used. Methyl-ethyl-ketone-peroxide (MEKP) and cobalt is used as a hardener which has accelerated the reaction. PTFE was filled in different various proportions and Developed PTFE filled and unfilled E-Glass-Polyester composite. Tribological properties of developed unfilled and filled were tested by Ducom Abrasive Wear Tester.

### 1.2 Composition Development of Composite Material

Bi-directional woven mat of E-glass fiber of different length are used to prepare the composite. The unsaturated polyester resin and hardener (Methyl Ethyl Ketone Peroxide (MEKP)) were mixed in the ratio of 100:10. The three composites samples were prepared using the hand-lay-up technique followed by the compression using compression moulding machine.

First sample of E-glass polyester reinforced composite is prepared by using woven mat of 300×300 mm size by placing layer by layer of 10 mats with layer of polyester resin, 1% of cobalt accelerator and 10% of methyl-ethyl-ketone-peroxide (MEKP) by weight as hardener is mixed in the resin prior to reinforcement. Another Two samples were prepared by taking the same composition filled with 10% and 20% of PTFE by weight to resin. It was put under pressure of 1 N/mm$^2$ and temperature of 120$^0$C for 2 hours in Compression Moulding Machine (Figure 1.1). All three developed composites samples were cured in the room temperature for 48 hours.

### 1.3 Compression Moulding Machine

It is used to make the composite and to give the desired shape as required by the process of compression of the composite as per the required pressure and temperature. It consists of reciprocating ram used for compression of the composite at required pressure. It can create pressure up to 400kg/cm$^2$ also it contain a inbuilt heater which can heat the material up to 600 $^0$C. All these parameters are handled with the help of electronic panel arrangement as shown in fig 1. Before compression the composite is prepared in the mould or it can be prepared outside the mould then it can be placed inside the mould. As the composite is prepared then it is followed by the compression at required pressure and temperature. The required pressure and temperature is manually set on the machine.

**Fig -1**: Compression Moulding Machine

Figure 2, 3 and 4 shows the prepared samples-

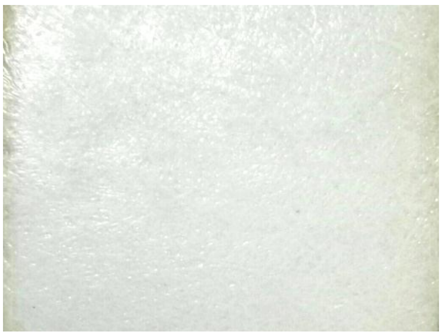

**Fig -2**: E-glass polyester composite

**Fig -3**: Composite with 10% PTFE filler

**Fig -4**: Composite with 20% PTFE filler

## 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 were 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, 7N, 10N, 12N ). The weight loss due to the abrasion wear is recorded using weighing machine, the difference in the weight results 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.


**Fig -5**: Two Body Abrasion Tester Machine

## 3. RESULTS AND DISCUSSIONS

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

- Unfilled – Base sample (E-glass fiber + polyester)
- 10% filled – Base sample + 10% PTFE of polyester
- 20% filled – Base sample + 20% PTFE of polyester

**Table -1:** Testing parameters and results

| S. No. | Sample | Load (N) | Sliding Speed (mm/s) | Sliding Cycle | Wear |
|---|---|---|---|---|---|
| 1. | Unfilled | 5 | 60 | 400 | 0.1011 |
| 2. | 10 % Filled | 5 | 60 | 400 | 0.0835 |
| 3 | 20 % Filled | 5 | 60 | 400 | 0.0998 |
| 4 | Unfilled | 7 | 60 | 400 | 0.1131 |
| 5 | 10 % Filled | 7 | 60 | 400 | 0.0928 |
| 6 | 20 % Filled | 7 | 60 | 400 | 0.1077 |
| 7 | Unfilled | 10 | 60 | 400 | 0.1311 |
| 8 | 10 % Filled | 10 | 60 | 400 | 0.1028 |
| 9 | 20 % Filled | 10 | 60 | 400 | 0.1227 |
| 10 | Unfilled | 12 | 60 | 400 | 0.1440 |
| 11 | 10 % Filled | 12 | 60 | 400 | 0.1101 |
| 12 | 20 % Filled | 12 | 60 | 400 | 0.1298 |

The results of the abrasive wear test of the three composites (samples) at constant parameters but at different loading conditions (5N, 7N, 10N and 12N) has been listed in the table 3, 4, 5 and 6. The results shows the significant role of PTFE filler in the E-glass polyester composite, results shows the less wear in PTFE filled composite than the unfilled composite.

- 10% PTFE filled sample shows the less wear than the 20% filled PTFE and the unfilled composite.
- 20% PTFE filled composite gives the less wear than unfilled PTFE composite.
- Results also stated that increase in the PTFE percentage from appropriate quantity reduced the wear resistance of the composite and hence increases the wear.
- Increase in the wear with respect to the increase in the PTFE percentage is due to the week bonding between the matrix and filler material (PTFE).

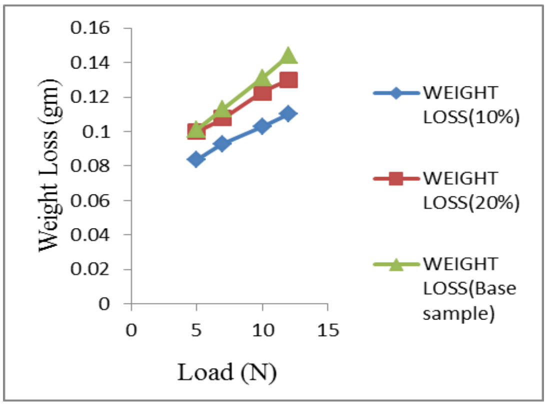


**Chart -1**: Load v/s Weight Loss

The results also indicated the ratio of PTFE filler should be in appropriate quantity because as the PTFE percentage is increasing in the composite the resistance to wear getting decreases because due to increase in the PTFE percentage the bonding between the resin and filler (PTFE) gets week and the upper layer of the composite get soften due to the week bonding between the filler and resin and hence results in the wearing of the layer.

## 4. CONCLUSIONS

The following conclusions are drawn from the above investigation-

- Reinforcing of PTFE filler contributed in reducing friction and exhibited better wear resistance properties.
- PTFE 10% filled composite exhibits higher resistance to abrasive wear as compared to 20% PTFE filled composite and unfilled polyester composite.
- As the load increases from 5N to 12N the wear of all samples also increases.

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

Important observation has been obtained from the experimental results that increased in PTFE percentage in composite composition results in increasing of wear. It has been observed that 20% PTFE filled composite exhibits higher wear than 10% PTFE filled composite. Therefore to obtain the better resistance to wear PTFE filler inclusion into composite should be in appropriate percentage ratio.

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