International Journal of Scientific Research in Mechanical and Materials Engineering
© 2018 IJSRMME | Volume 2 | Issue 5 | ISSN : 2457-0435

Abrasive Study of ELT Rubber Loaded with Fibre Reinforced Plastics

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ABSTRACT

Study on end of life tires impact on major material reuse operation to predominant the recyclable use in tribological applications due to the fact that it yields better termination over abrasive loading when it is proportionate with the potential lightweight materials. The favourable properties of these lightweight structures forms familiar group while opting type of materials suggesting for particular applications. In addition to this the performance of fibre reinforced plastics is increased to greater extent by adding filler materials in to the matrix material ,unlike unfilled polymer structures, filler composites enhance excellent abrasion resistance when it is shaped by adding small amount of filler in different percentage with respect to the volume of the matrix. The present work highlights the importance of E-waste rubber which is directly obtained from waste tires which is powdered and sewed. The particle size is limited to 150µm which is then mixed to the matrix and cured the samples by adding filler with smaller percentage which is increased gradually say 5%, 10%, 15% by weight of the matrix considered. The samples were prepared by hand lay-up technique, the prepared samples were cut and tested as according to ASTM standard, wear study has been carried out successfully for finished samples with the help of pin-on –disc apparatus. It is observed from the result that the samples loaded with high percentage of rubber powder shows excellent resistance to wear and this fashion is reduced upon reducing the amount of filler added to the polymer matrix, this is basically because of the rubber grain forms magnificent obstacles to wear loading and thereby excel huge resistance to abrasive wear when these are exposed to experience varying load and speed.

Keywords : E-Waste rubber, Wear Behaviour, FRP's, Filer Composites

I. INTRODUCTION

Composites comprising of mixing of one or more materials combined in a macroscopic range with the help of special techniques enlarges the qualitative internal properties of resultant material under the set of testing conditions such a way that one of the background material acts as the matrix to bind and gives actual shape for the material and other as reinforcement which bears the applied external load. Preparation of composites involves proper selection of polymer and reinforcing material and addition of filler material to the matrix system, however increase in filler content in the GE composite enhances the young's modulus, flexural strength, surface hardness, brittleness and decreases the tensile strength and elongation at break [1]. One of the main concerns that encountered in design of machine parts which are specially made of polymer matrix composite materials is demand for reliability and long life of such machine parts. This is due to failure of such components during working condition. Meanwhile, the main reason for failure of such sliding parts is not only breakage but also wear or surface deterioration due to rubbing against other hard surfaces. This also necessitates better understanding of sliding wear mechanism at the worn surfaces in order to design parts with optimum wear and friction characteristics. This can be ascertained by studying the modes of damage and their correlation to operating test parameters [**2**]. Polymers and their composites are widely used in many situations where machine components are subjected to tribological loading conditions. Increase in the use of the composite materials mean that it is necessary to know their behaviors under working conditions. For such components it is imperative to understand the possible wearing mechanism under specific sliding conditions. Furthermore many researchers have reported that the wear resistance with polymer in sliding against steel improved when the polymers are reinforced with glass or aramid fibres. However, the behavioris affected by factors such as the type, amount, size, shape and orientation of the fibres, the matrix composition and the test conditions such as load, speed and temperature [**3**]. In view of this, the present work is intended to use a fundamental approach to investigate the different wear mechanisms at worn surfaces due to dry sliding against smooth stainless counter face. Therefore, tribological properties of woven roving bidirectional fibre glass reinforced epoxy (BGRP) composite are determined experimentally.

Literature study also revealed that, The glass fibres reduce the quantity of water absorbable material and thus, the water asorption of FRC should be less compared to that of the matrix polymer[**4**] in addition to this, introduction of the fillers in to polymeric system comprising of fibrous reinforcement would enable the user to achieve the better mechanical properties and also to have the optimum wear rate and coefficient of friction, also percentage of filler in fibrous reinforcement effect the wear rate on the filler %. No much work was observed on this aspect as adding E-waste rubber powder as filler material and the effect of rubber filler percentage on wear rate of polymer composites. Keeping this objective in mind, it was decided to study the dry slide wear characteristics of E-glass fibre epoxy (GE) system having varying percentage by weight of E-waste rubber as filler

II. FABRICATION OF SPECIMENS

With the help of woven fabric (360gsm) as a reinforcement material and epoxy resin (araldite GY250) as a matrix material with the hardener (teta) was effectively utilized for the successful completion of fibre reinforced plastics. With the introduction of highly pronounced E-waste product which is normally available abundantly and most categorized non-bio degradable material called scrap wheel tires of an automobile. Owning to its property of abrasion resistance rubber powder is proportionally loaded to polymer system to asses wear behavior of finished FRPs. To accomplish this scrap tires are collected primarily and powderd to limited microns is used successfully as a filler material to load in composite structures with different percentage. Glass fibre constitutes with fine threads which contributes greatly against external loading due to glass fibre shows exceptional properties. Even though glass fibres are not strong as like graphite fibres,because of negligible brittlness and availability with less price makes these fibres are chosen as better option to consider it as reinforcing material. Here type of glass fibre used is E-glass; The Electrical insulators (E-glass) composed with oxides of silica, aluminium and calcium. The glass fiber is known for calcium alumino borosilicate glass. Epoxy resin with lesser molecular weight pre polymers which are being processed under a different conditions. In this present research work E-waste rubber powder is used as a filler material which is finely grinded which is as shown in fig.1.The arrangement of die for synthesizing composites and compressing arrangements are shown in Fig 2.

Fig1. E-waste rubber powder (120μm)

Fig 2. Die arrangement

By volume fraction calculation,16 layers of 250x250 mm sized E-glass woven fabric laminates were cut and corresponding amount of Epoxy resin was weighed. Required amount of powdered filler was added. The different percentage (5%, 10%, and 15%) of filler material was added to the resin and hardener mixture. The epoxy and hardener proportion ratio of 10:1 was premixed and thoroughly stirred before starting layup process. The surfaces of the laminate will be completely cleaned to ensure that the laminates are free from any impurities. This process is primary operation that could be carried out before binding of laminates takes place with room temperature and pressure. The most convenient method, hand layup technique was employed as the glass fiber along with resin was compressed and allowed to cure for 24hours in the die arrangement. Prepared sample thicknesses of 4mm are maintained. Fabricated and completely cured woven fabric specimen is as shown in fig 3.

Fig3. Woven Sample

III. EXPERIMENTAL METHOD

The wear test is conducted by using the Pin on disc apparatus. A pin on disc tribometer consists of a stationary pin under an applied load in contact with a rotating disc. The pin can have any shape to simulate a specific contact, but spherical tips are often used to simplify the contact geometry. Friction is determined by the ratio of the fractional force to the loading force on the pin. Fig.4 represents the schematic diagram of the pin-on-disc test procedure. Sliding wear takes place due to relative sliding of two surfaces in contact with each other under the influence of applied pressure.The fig.5 represents arrangements of sample.

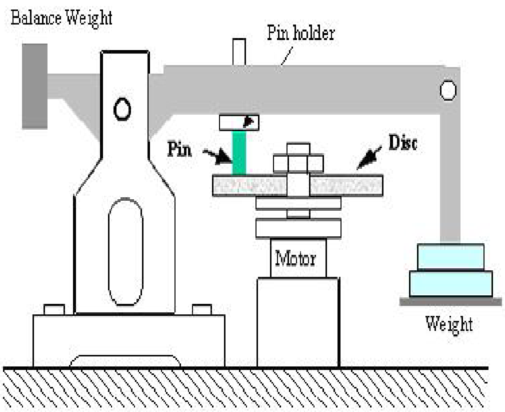


Fig 4: Pin-on-disc apparatus

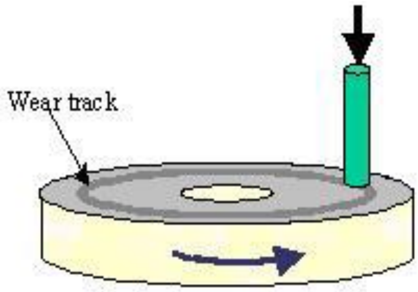


Fig 5. Arrangement of samples

Materials are tested in pairs (pin and disk) under nominally non-abrasive conditions. Pin on disc apparatus is a unit to determine the wear of the materials during sliding. For the pin-on-disk wear test, two specimens are required—a cylindrical pin specimen and a flat disk specimen. The test machine causes the disk to revolve about the disk center causing the pin to slide on the disk surface in a circular sliding path. The pin specimen is pressed against the disk at a specific load by means of an arm level and attached weights.The specimen for test is cut from cured laminate by using wire cutting machine, so as to yield 5x5 mm test coupon and is as shown in Fig.6.

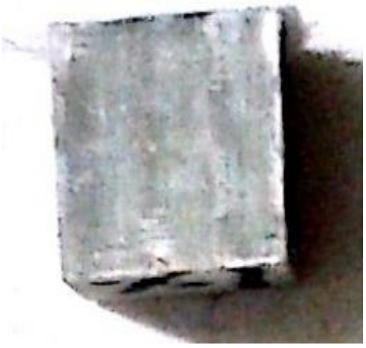


Fig6. Wear Test Sample

Testing condition and parameters are

- Load; 40 N
- Disc material: En 31 hardened to 60 HRc ground to 1.6 Ra surface roughness
- Disc speed: 600 & 1200 RPM
- Specimen dimensions: 5 x5 x4 mm^3
- Sliding condition: Un-lubricated
- Readings were taken for 5 min for both different speeds
- Testing condition - Normal ambient condition

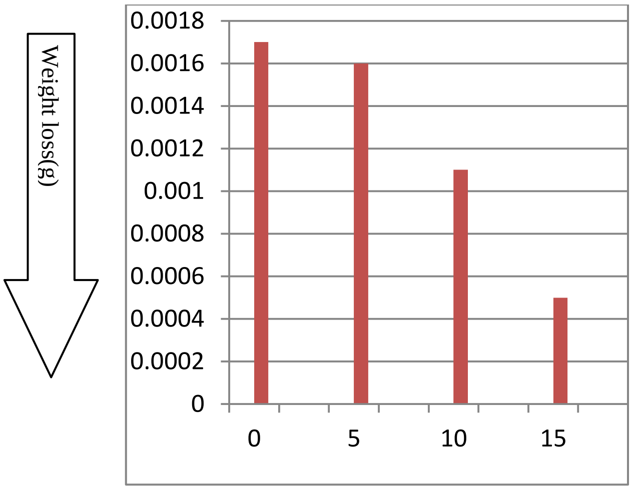
IV. RESULTS & DISCUSSIONS

Pin on disc apparatus is used to conduct wear test on specimen of dimension (5*5*4) mm maintaining parameters such as wear test time, load and track diameter constant. Tabulation of wear test for two different rpm speed is shown in table 1 and table 2 and the corresponding results are plotted which is as shown in graph 1&2 respectively.

For Speed = 600 rpm, Time =5 minutes, Load = 4 kg, Track diameter = 100mm

Filler % in specimen	**Wear loss**
0 %	0.0027
5%	0.0016
10%	0.0003
15%	0.0002

Table .1



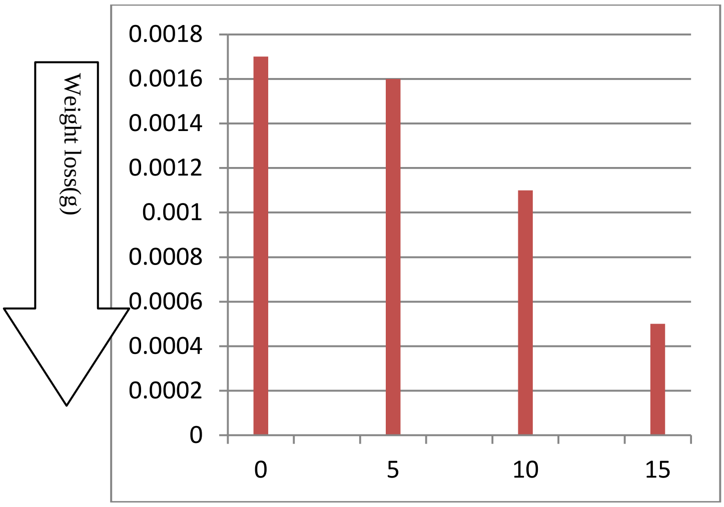
Filler % (by weight)

Graph.1

For Speed = 1200 rpm, Time =5 minutes, Load = 4 kg, Track diameter = 100mm

Filler % in specimen	Wear loss
0 %	0.0017
5%	0.0016
10%	0.0011
15%	0.0005

Table .2



Filler %

Graph.2

Pin-on-disc Wear test has been conducted succefully for prepared three samples by adding different percentage by weight of E-waste rubber filled composites. From graph it is clearly depicted that addition of rubber powder to polymer matrix enhance higher wear resistance of polymer composites and there is gradual decrease in wear rate has been observed compared with unfilled E-glass/epoxy composites and this trend continues as filler percentage increases wear rate decreases and the material respond hardly against external load for two different speeds but higher wear loss has been observed at 1200 rpm of disc speed compare to 600rpm and resistance to external speed and load by rubber grains to safeguard exterior of a material by restricts the easy flow of surface material upon external rubbing action has been noted experimentally supporting to the abrasive behaviour of rubber powder within the polymeric system.

V. CONCLUSION

The successful utilization of ELT rubber as a filler material has been carried out and samples of GFRP laminates are prepared by employing conventional Handlay up technique. Successfully completed the fabrication on E-glass /epoxy by using E-waste rubber with different filler percentage and these are the following results. At 15% filler specimen undergoes minimum wear rate. For 600 rpm, there is 92.60% decrease in wear rate from 0% to 15% filler material of the sample. For 1200 rpm, there is 70.60% decrease in wear rate from 0% to 15% filler material of the sample. Glass fibre-Epoxy resin composites generally showed higher wear resistances if we compare with glass fibre polymer matrix resin composites material. It is concluded that reductions of about (62-88) % in friction and (30-75) % in wear rate is achieved, again depending on the value of applied normal load and speed.

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