RESEARCH ARTICLE OPEN ACCESS

Friction and Wear Behavior of Epoxy Composites Reinforced With Ipomoea Carnea Fiber under Dry Condition

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ABSTRACT
This present paper depicts the effect of normal load on the wear (micron) and coefficient of friction of Ipomoea Carnea strengthened/reinforced epoxy composites with various weight % of fiber fraction (10%,20%,30%,40% wt). The dry sliding wear test was studied according to ASTM-G99 standard using Pin-on-Disc Tribometer manufactured by DUCOM Instruments Pvt. Ltd. To calculate the wear in micron and coefficient of friction of Ipomoea Carnea reinforced epoxy composites the pin of 12 mm diameter of given fiber composites were fabricated and tested under three different loading conditions (10N,20N,30N) for each fiber weight concentration. Friction and wear measurement was accomplished through load cell and LVDT respectively. The Pin-on-Disc Tribometer acquired real time data of wear, and coefficient of friction with time(sec). Each test were conducted for 10 min (600 sec) under dry condition and data for wear (micron) and coefficient of friction with variation of time (100 sec interval) were recorded from the monitor and graphs from obtained data were plotted in Microsoft excel.
Keywords – Composites, Pin-on-Disc, wear, friction, LVDT

Date of Submission: 28-07-2018 Date of acceptance: 13-08-2018

I. INTRODUCTION

Amid the most recent century, common filaments and particulates are utilized as reinforcement in polymer composite that has been constantly developing in the composite industry. This polymer matrix composite has extensive variety of uses in antagonistic condition where they are presented to outside assaults, for example, strong molecule disintegration. Bio and mechanical waste are finding expanded application under various conditions in which they might be used as value added products. Numerous researchers are searching for new materials because of the lack of metals. Their overview uncovers that natural waste products have the potential to supplant the conventional materials. These common waste items incorporate sisal, bamboo, banana, ramie, coconut shell, jute, rice husk and so on. Which are pleasing due to their low cost, high strength to weight ratio, completely renewable or partially, good insulating properties and biodegradable [1-4].

According to the writing works scientists worldwide have attempted and demonstrated that natural fibers like banana, sisal, jute, bamboo, wheat, sugarcane, flax can effectively use as reinforcement in polymer composites, thermoplastics and thermosets [5-13]

In the exploration of the impact of characteristic of natural fiber reinforced polymer composites in tribological applications, broad research work has been distributed on different kinds of polymers and fibers. Ojha Shakuntala Et al.[14] have reported the effect of fiber loading of wood apple shell reinforced epoxy composite on their mechanical and tribological properties. They studied density and void content of apple shell particulate composites as well as tensile and flexural properties. Gaurav Agrawal, Amar Patnaik Et. al.[15] studies the three-body abrasive wear behavior of short Kevlar fiber reinforced epoxy composites. They studied specific wear rate under different normal load and sliding velocities. Anaya Arun and Kalyan Kumar Singh [16] studied fiction and wear behavior of glass fiber under dry and oil lubricated conditions. They fabricated composite using vacuum bagging process and concluded that COF and wear rate is less in lubricated conditions.

In 2014 Kamal Kumar Basumatary, Niharika Mohanta Et. al. [17] studied the effect of fiber loading of Ipomoea Carnea reinforced composite on abrasive wear rate. They conduct experiment on Pin-on-Disc apparatus under varying loading condition at different velocities.

From the concise writing referred to above it is clear that very little study have been led utilizing Ipomoea Carnea fiber. In this paper effect of normal load on wear and friction behavior of epoxy composite reinforced with Ipomoea Carnea fiber with different fiber concentration were studied. During the investigation sliding velocity, track diameter of 100 mm kept constant while normal load vary from 10N to 30N for each fiber concentration.

II. MATERIALS AND METHODS

2.1 Materials

In the present investigation Epoxy resin of Araldite MY-750 and hardener of HY-951 were used with a composition of 2:1 respectively. Ipomoea Carnea plant (Fig.1) locally called ‘Beshram’ in india were obtained from nearby rivers and ponds. The plant mainly grows nearly rivers and ponds and is poisonous for creatures. The stem of Ipomoea Carnea is obtained and upper husk were removed (Fig.2) with the help of scissor or some other point tools without damaging the inner fiber. After removing upper husk the stem is then cut into two halves (Fig.3) and inner spongy material is removed (Fig.4) and allows drying in sunlight for one day. After drying the stem is then cut into small pieces (Fig.5) and for removing remaining moisture from it those small pieces was dried in an oven at a temperature of 60°C for an hour. Dried pieces were grind into fine powder and with the help of sieve (100 micron) powder was collected (Fig.6) in a pot.

Fig.1 ipomoea carnea plant

Fig.2 removing upper husk from stem

Fig.3 stem cut into two halve

Fig.4 removing inner spongy material

Fig.5 stem chopped into small pieces

Fig.6 collected powder of ipomoea carnea

2.2 Fabrication Process

Epoxy resin and hardener were mixed in 2:1 ratio respectively and obtained powder of 10% weight fraction is mixed with it and stir gently to obtained homogenous mixture of reinforced composite as shown in 'Fig.7'. same process were carried out for making 20%, 30% and 40% weight fraction reinforced composite.

Fig.7 mixing and stirring process of composite

To make samples of 12mm diameter first prototype of 12mm diameter (Fig.9) sample of were made on lathe machine (Fig.8). Plywood mould of required dimension was made and inner part of that plywood mould was coated with release agent like wax as shown in Fig.10. For making sample pins, first silicon mould were prepared with the help of Moldsil 15 base part (part A) and catalyst 16 (part B) these two mixed in 2:1 ratio respectively and poured in plywood mould (Fig.11) to obtained sample pins of 12mm diameter. After pouring mixture is allow to dry for 4 to 5 hour at room temperature to obtain the 12mm bore of prototype. The mixture of composite is then poured in the 12mm bore in silicon mould and allows drying for 8 hours (Fig.12). After drying composite pin (Fig.13) is removed from silicon mould.

Fig.8 preparing prototype of 12mm diameter on lathe

Fig.9 prototype of 12mm diameter

Fig.10 coating plywood mould with release agent (wax)

Fig.11mixture of silicon is poured in plywood mould

Fig.12 composite filled in 12mm bore

Fig.13 fabricated composite pins

III. EXPERIMENTAL DETAILS

Dry sliding wear test has been carried out under dry condition and at three different loading conditions (10N, 20N, and 30N) while parameter such as sliding distance and track diameter was kept constant throughout the investigation. Pin-on-Disc tribometer manufactured by DUCOM instruments Pvt. Ltd (Fig.14) were used for dry sliding wear test.

Fig.14 ducom pin-on-disc tribometer

The tribometer determines the wear (micron) and coefficient of friction of metals under sliding contact. The tester was operated with composite pin positioned perpendicular to the flat circular disc. The test machine causes the disc specimen to revolve about the disc center. Machine/tribometer is compatible to conduct tests confirming to ASTM G99 standard. Friction measurement is accomplished through load cell and wear between specimen pin and disc is measured using LVDT sensor. The signals from sensors after processing in controller are transmitted to PC (Fig.15) and are displayed on software screen.

Fig.15 monitor showing wear and COF

Test was conducted on 3 different loading conditions at 10 N, 20N & 30 N for different fiber content at 200 rpm. The observations of wear in micron, frictional force (N), and coefficient of friction is measured with time (sec) at varying loads. The wear, and coefficient of friction at different load are tabulated and graph were plotted.

IV. RESULTS AND DISCUSSIONS

The variation of wear (micron) and coefficient of friction with time (sec) were plotted using values obtained during test for different fiber concentration and at different loading conditions. To plot effect of varying load (10 N, 20 N & 30 N) on wear (micron) we used wear values at time 300 sec at each load and each fiber contents. Also to plot effect of varying load (10 N, 20 N & 30 N) on coefficient of friction we used average value of each load at different concentration of fiber.

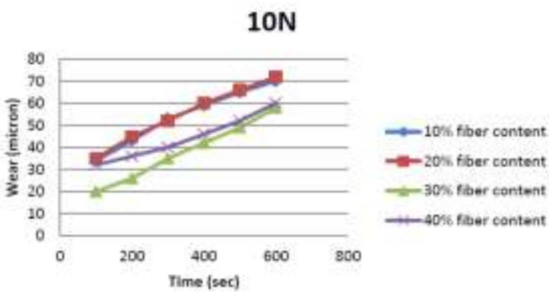

Fig.16 variation of wear with time (sec)at 10N loading condition

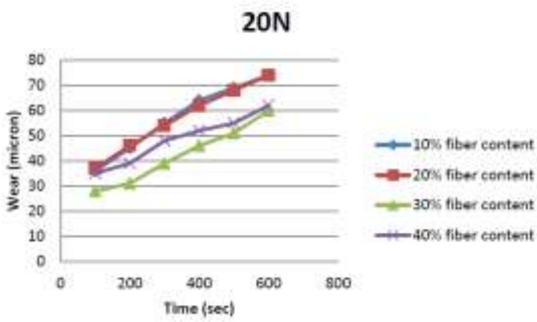

Fig.17 variation of wear with time (sec) at 20N loading condition

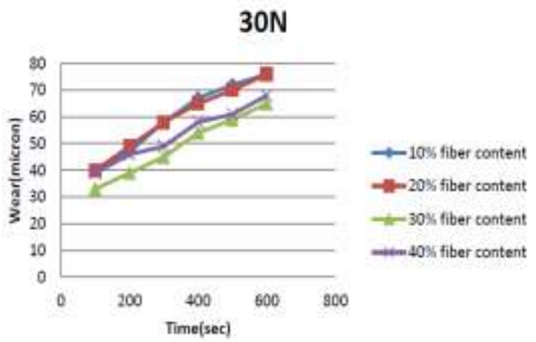

Fig.18 variation of wear with time (sec) at 30N loading condition

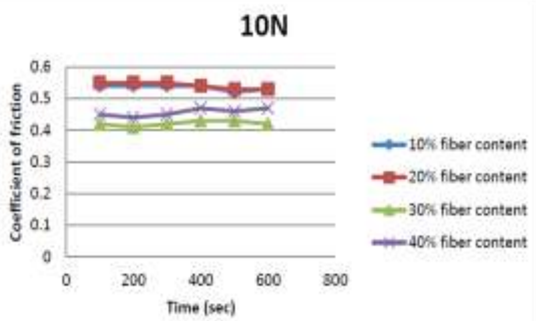

Fig.19 variation of coefficient of friction time (sec) at 10N loading condition

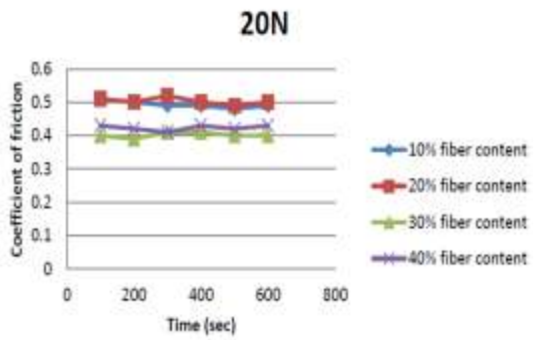

Fig.20 variation of coefficient of friction time (sec) at 20N loading condition

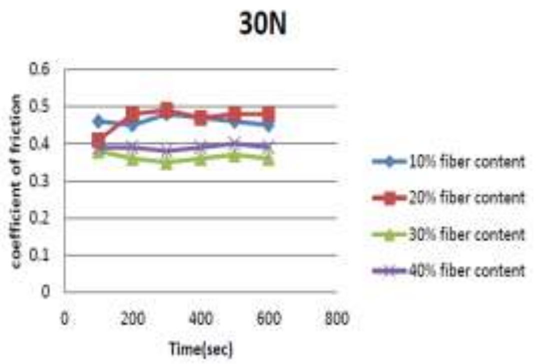

Fig.21 variation of coefficient of friction time (sec) at 30N loading condition

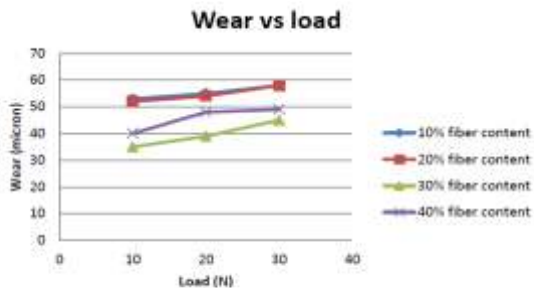

Fig.22 effect of wear (micron) on different loading conditions

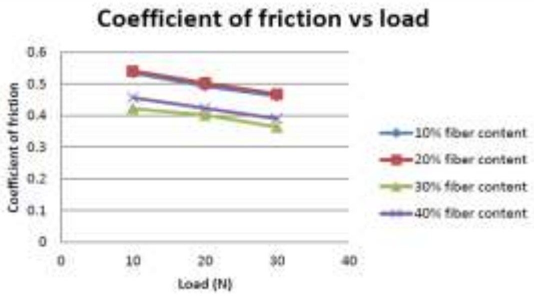

Fig.23 effect of coefficient of friction on different loading conditions

From Fig.16 to Fig.18 this shows variation of wear (micron) with time (sec) for different loading conditions. It is clearly seen that wear increases with increase in load from 10 N to 30 N. wear (micron) increases with time from 100 sec to 600 sec. minimum wear is obtained in 30% fiber content samples. Further increase in fiber content after 30% wear increases. Similarly from figure 5.18 to 5.20 variation of coefficient of friction with time (sec) were plotted and it shows that coefficient friction decreases with increase in load. Coefficient of friction of all samples is in between 0.3 to 0.6.

Wear was relatively low at normal load (10N) because of less number of rough particles in action with the rubbing surfaces. Wear was greatly increased at higher load because most of the abrasive particles come into action and creates more grooves. The grooving action results more material removal and can be termed as ploughing. This can also be attributed to the fact that at higher loads the frictional thrust increases, which result in increased debonding and fracture. A similar effect of normal load on volumetric wear rate has been observed by Cirino et al [18] in the case of carbon epoxy composite and Anay Arun and Kalyan Kumar Singh [16] for GRP composite.

V. CONCLUSION

Based on experimental results of abrasive wear of Ipomoea carnea particulate epoxy composite it is concluded that wear increases with increase in load from 10N to 30N. Minimum wear found in sample of 30% fiber content. Further increase in fiber content above 30% results in drawing out of fiber from the resin due to poor interfacial adhesion. Coefficient of friction decrease with increase in load from 10N to 30N. Minimum coefficient of friction was at 30N load and 30% fiber content.

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Nitin Doifode "Friction and Wear Behavior of Epoxy Composites Reinforced With Ipomoea Carnea Fiber under Dry Condition "International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.8, 2018, pp. 22-27