Fiber Surface Treatment Effects on Wear and Friction of Luffa/Polyester Composites

S. Saravanasankar, G. Kalusuraman, I. Siva

Abstract- In this work, the extracted fiber from the luffa plant is used as for making of composite with unsaturated polyester. As received (UT) and alkali treated fibers(NT) are used for making laminates. All the composites have been made with an optimal pressure of 50 kg/cm2 with room temperature curing of 12h. Evicted specimens were cut in to the dimensions as per respective ASTM standard. The surface treatment effects on the coefficient of friction (CoF) is measured using pin- on-disc wear set-up machine. Results shows that the impact strength of the composites increased afterward surface treatment. Meantime, the coefficient of friction also increased in the treated fiber composites. Experiment is conducted for three different sliding velocity for 3000m of abrading distance

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Keywords: Luffa fiber, polyester matrix, sliding velocity, coefficient of friction.

I. INTRODUCTION

Natural fibers (NF) have been encountered much more interest among the researchers for over the past decade. Natural fibers are now considered as a serious substitute for the synthetic fiber as reinforcement. The pros of natural fibers over synthetic fibers are their low density, low cost. high strength-to-weight ratio, low energy content and recyclability [1, 2]. Gianpietro et al. [3] described that the Luffa fiber was composed of 10% lignin,30% hemicelluloses and 60% cellulose. Another work studied by Tanobe at al. [4] that data characterized Luffa fibres extracted from the brazillian spounge gourd and reported that chemical/ physical modification of the Luffa fibre enhanced their properties of composites. Mazali et al. [5] and demir et al. [6] described that the Luffa composite would be a potential material with less water absorption for packaging applications.

Manufacturing process of composite is important techniques in determining the strength of composite. Compression molding method is one of the best methods for making of composite providing the better strength [7]. Amico et al. [8] found that the composite produced by compression molding yielded better strength in all aspects of the composites. Hence, in this work, compression molding is followed. However, there is some research gap in mechanical properties of the Luffa in the entire research reports especially in the Tribological area. This investigation focused the effect of fiber surface treatment on the coefficient of friction(CoF)of the Luffa/Polyester composites. Siva et al. [9] detailed the significance of directing the dry sliding wear test for the natural fiber composite and deliberated the effect of surface treatment on it. Only very inadequate amount of works has been reported on the Luffa. Hence, the influence of fiber surface treatment on the impact strength and frictional behaviour of Luffa reinforced composite became more important and reported here.

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II. EXPERIMENTAL PROCEDURE

A. Materials and methods

Luffa is used as reinforcement in the form of mat (Figure1); the fibers are collected from the nearest agriculture field of Rajapalayam/TN,India. Unsaturated polyester(USP) is used as resin. Methyl ethyl ketene peroxide (MEKP) and cobalt-naphthenate supplied by Vasavibala Resins Chennai/TN, India were used as accelerator and catalyst respectively. The Sodium hydroxide used as fiber surface treating agent and supplied by Modern Scientifics, Madurai/TN, India.

Fig. 1. Image of the Luffa fruit fiber

Fiber surface modification is done with the 1N alkali solution. One mole weight (40g) of NaOH is added to the 1000ml of distilled water to prepare a one molar solution. Pre-dried Luffa fibers are immersed into the prepared alkali solution for an hour. Treated fibers then washed several times to confirm the removal of excess NaOH from the fiber surface followed by the hot air over at 60° C for 24h for drying.

B. Composite fabrication and testing

The fibres were taken and are combed perfectly to remove the dirt from the fibre surface. Then the dirt free fibres were cut to 12mm length. Similarly, basalt fibres are also cut in to 12mm length. Then the fibres were placed in the mould cavity of 300mmx300mmx3mm. Resin transfer moulding technique was carried out for the fabrication of the composites. The compressed air was injected to the pressure vessel at 1.5 bar and the resin was transferred to the mould cavity from the pressure vessel. The composites were allowed to cure for 4 hrs. The prepared composites were cut to the ASTM standards and a tribological test was carried out

Table 1. Notations used in composite fabrication

SL	Notation	Meaning
1	UT30	30 wt.% Untreated Luffa fiber + Polyester
2	NT30	30 wt.% NaOH treated Luffa fiber + Polyester

After a 12h room temperature curing, finally the composite has been taken out from the mold, the fo llo wed b y c utti n g o f sp eci men a s p er the ASTM standard.Impact strength of the un-notched composite samples are measured in the digital impact-testing machine as per ASTM D256. An average of five readings are reported. ASTM G99 is followed for conducting the dry sliding wear tests. Samples of $10mm^3$ cube is used. Surface of the sample is placed parallel to the alloying steel counter disc. Before placed, the surface of the specimen and disc are cleaned with an emery paper.Test is conducted for three different sliding velocities (2m/s, 3m/s, and 4m/s). A common applied load of 10N is maintained throughout the experimentation. Test is continued until the reach of 3000m abrading distance. Friction coefficients are measured in the interval of 300m running and plotted. An average of five is reported in each experiment. The frictional forced exerted in the composite- counterpart interface is measured using a force sensor. Coefficient of friction is calculated by the following formula,

(CoF) = P/F ---(1)

Where, P is applied load
F is measured frictional force rate.

III. RESULTS AND DISCUSSION

A. Impact Strength

Figure 2 shows fiber surface modification effects on the un-notched impact strength of the Luffa/Polyester composites for the various fiber loading. A significant enhancement of the impact strength of the composite noted after the surface modified fibers used in expect to the higher fiber loading. moreover, in many literature, a positive influence of the fiber surface treatment is reported [4]. As expected in Luffa fiber also the same results received. A good mechanical interlocking and porous nature of the natural fibers generally attributes the improved mechanical properties. Especially, when treated with the alkali solution, more sponge nature of the vegetable fibers exposed into the composite interfaces, which resulting good impact resistance.

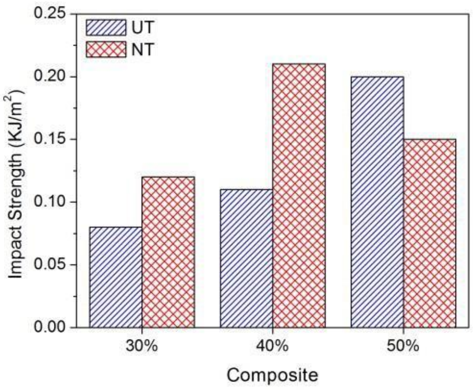

Fig. 3. Fiber loading effects on impact strength

B. Coefficient of Friction

Figure 3 shows the change in coefficient of friction with respect to abrading distance for the untreated Luffa/Polyester composites(UTC) sliding against steel surface which is having surface roughness of Ra 0.54 µm. Samples are abraded in three dissimilar velocities for the common applied load of 10N. The velocities are 2, 3 and 4 m/s.

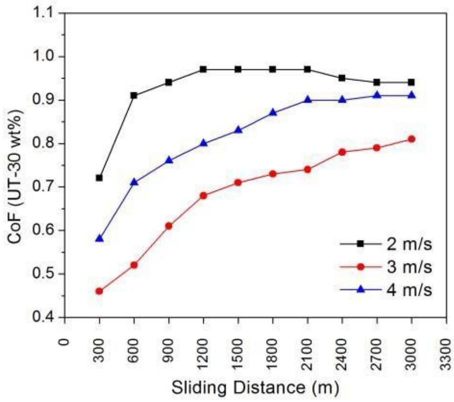

Fig. 4. Effect of sliding velocity on coefficient of friction of untreated fiber composite

For the low sliding velocity, the coefficient of friction of UT30 composite is high at onset as 0.72 and further increase significantly up to 1200m (0.96). More, until 2100m run, a steady state is followed by a fall in the CoF. The steady state and fall in CoF are attributes due to bulk wear debris of specimen. [9]. Perhaps, the wear debris form a protective layer over the composite counterpart, resulted the steady state in CoF and the same which prevents the Luffa fibers to steel disc contact. This results the fall in the CoF and offer a smooth sliding of the composite on the counterpart disc for a long time. UT30 composite also shows the similar trend of slower velocity running when it runs at 3 m/s Unlikely, at higher sliding velocity, less CoF is noticed than the slower sliding velocity (2 m/s). At initial condition, 0.46 is noted which is the least one among the others; but in running period, significant rise in CoF is noted.

Frictional coefficient for

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very high running velocity (4m/s) shows more values than the previous sliding velocity (3 m/s) data. At onset, the coefficient of friction is 0.58, steady state achieved in the 4 m/s sliding velocity only at 2100m. Nevertheless, no significant fall in frictional forced value logged throughout the running period.

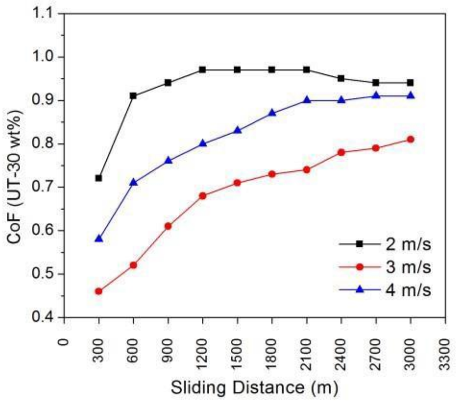

Fig. 4. Effect of sliding velocity on coefficient of friction of Alkali treated fiber composite.Composites with treated fiber reinforced (30wt% of Luffa fiber) also undergone a wear analysis for three different velocities (2, 3 and 4 m/s.) and displayed in the Figure 4. Surface modification effectively changed the coefficient of friction in all the sliding velocities. A similar trend in lower sliding velocity of the untreated composite is noted in the treated composite. Nevertheless, no steady state is achieved throughout the running period. Additionally, no fall in the coefficient of friction also noted. For the next higher level of sliding velocity, similar trend of increase in coefficient of friction is noted, nonetheless, lower friction is recorded. Since the treated fibers have more mechanical compatibility with polyester matrix less fiber surface exposed to the counterpart during medium sliding velocity. Since such a less frictional forced resulted. The same is also recorded in the higher velocity running (4 m/s). However, the fall in the frictional forced coefficient is noted at the exit. This attributes, at very high sliding velocity, wear debris wash-out may cause, hence a fall in the coefficient resulted

IV. CONCLUSIONS

The following are concluded from the experimental results

- Fiber surface treatment of the Luffa fiber significantly modifies the impact strength of the composite.
- The coefficient of friction varies with varying sliding velocity
- Higher the sliding velocities resulted smoothening of composite surface which attributed the fall in CoF.
- After the alkali treatment, the CoF of composite significantly reduced which may enable the particular composite can be further analyzed to find suitability for low friction application.

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