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Mechanical and Machining Characteristics of Luffa Aegytiaca Fiber Reinforced Plastics

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ABSTRACT

In current years composites have concerned considerable importance as a potential operational material. Low cost, light weights, high specific modulus, renewability and biodegradability are the most basic & common attractive features of composites that make them useful for industrial applications. With low cost, high specific mechanical properties natural fiber signifies a worthy renewable and biodegradable substitute to the most common synthetic reinforcement i.e. glass fiber. There are numerous potential natural resources in India. Most grows from the forest and agriculture. Luffa - aegytiaca locally called as sponge-gourd is one such natural resource whose potential as fiber reinforcement in polymer composite has not been explored till date for tribological applications. Against this back ground the present work has been commenced with an objective to explore the use of natural fiber Luffa as a reinforcement material in polypropylene base. The presented work in this includes study of two different problems of natural fiber composites:

a) A study of favorable mechanical and machining properties of luffa fiber in thermoplastic matrix composite.

b) An experimental analysis of mechanical and machining potential of Luffa fiber reinforced composite.

***Keywords*--** Luffa aegytiaca , mechanical and machining potential , thermoplastic

I. INTRODUCTION

1.1 Luffa fiber

Luffa aegytiaca, locally called as 'Sponge-gourds' is one such natural resource whose potential as fiber reinforcement in polymer composite has not been explored to date. It has a ligneous netting system in which the fibrous cords are disposed in a multidirectional array forming a natural mat. This fibrous vascular system is composed of fibrils glued together with natural resinous materials of plant tissue. It contains 62% cellulose, 20% hemicellulose and 11.2% lignin [1]. Owing to the high price of composites, the user industries also demand a lower price for production of fiber components and at the same time improvement in quality. It was found that these can be achieved with the use of natural fibers [2-5]. In these categories luffa cylindrica is one such tropical plant which originates from America [6] belongs to cucumber and marrow family.In the pursuit of visualising the importance of this fibre Lassaad Ghali etal [7] studied effects of Fibre weight ratio, structure and fibre modification on to the Flexural Properties of Luffa-Polyester composites.They observed that the chemical modification of luffa fiber enhanced the flexural strength and the flexural modulus. Boyand etal [8] studied the effect of alkali treated fibre on the flexural properties of the composite.

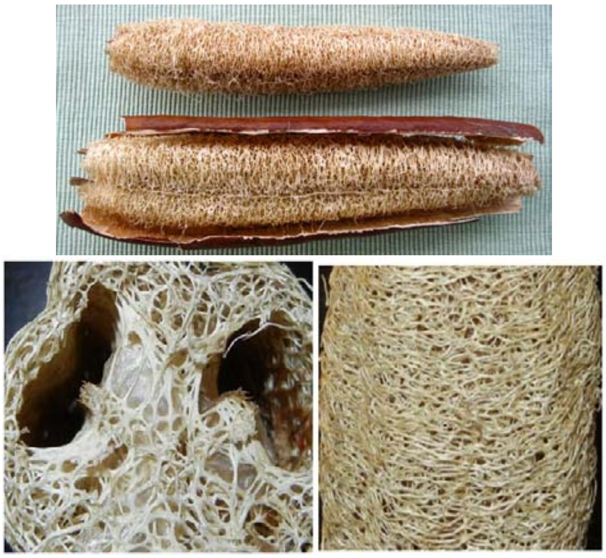

Fig1: shows Luffa Aegytiaca fiber

II. EXPERIMENTAL PROCEDURE

2.1 Fabrication of composite specimens

Proper proportion of fibres (0, 5,7.5, 10, 12.5,and 15%) by weight and polypropylene pellets were then properly mixed to get a homogeneous mixture. The mixture was then placed in a 2.5 tonne plastic hydraulic plastic Injection Moulding Machine, Model JIM–1 HDB, supplied by Texair Plastics Limited,Coimbatore as shown in fig2, At a temperature of 210 ^{0} C and at pressure of 1100 kgf/cm^2, all the five specimens were developed for each weight fraction of luffa fibre composites. Percentage of fiber in the composite is maintained by its weight fraction.

The standard test methods ASTM-D638M for tensile properties of fiber-resin composites, ASTM-D790M for flexural properties of fiber-resin composites and ASTM-D256M for impact properties of fiber-resin composites, were used to prepare specimens as per the dimensions. Five plain polypropylene specimens are also prepared in order to compare the results of natural fiber reinforced composites

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Fig2: Injection Moulding Machine

Fig3: Shows the Fabricated Composite Specimens to perform mechanical and machining characteristic

2.2 Testing (Tensile, Flexural, Impact& wear) & Machining of Specimens

A 2 ton capacity - Electronic tensometer, METM 2000 ER-I model , supplied by M/S Mikrotech, Pune, is used to find the tensile strength of composites. Its capacity can be changed by load cells of 20Kg, 200Kg & 2000 Kg. A load cell of 2000 Kg. is used for testing composites. Self-aligned quick grip chuck is used to hold composite specimens. A digital micrometer is used to measure the thickness and width of composites.

This Instrument is used for testing the composite specimens for both i.e. For Tensile Strength & Flexural (Bending) Strength

While for testing the impact specimen composites we use analog Izod/ charpy impact tester supplied by M/S International Equipments, Mumbai (photo), was used to test the impact properties of fiber Reinforced composite specimen. The Equipment with a minimum resolution on each scale of 0.02 J, 0.05 J, 0.1 J and 0.2 J respectively .Four scales and corresponding hammers (R1,R2,R3,R4) are provided for all the above working ranges.

Wear test have been conducted in the Pin-on-disc type Friction and Wear monitor (DUCOM; TL20) with data acquisition system which was used to evaluate the wear behavior of the composite, against hardened ground steel disc (En-32) Surface roughness (R_a) 0.5 μm. It is versatile equipment designed to study wear under sliding condition only. Sliding generally occurs between a stationary Pin and a rotating disc. The disc rotates with the help of a D.C. motor; having speed range 0-2000 rev/min with wear track diameter of 100 mm. Load is to be applied on pin (specimen) by dead weight through pulley string arrangement.

Fig4: Shows the Equipment for Testing the Composite Specimens (Mechanical Characteristics)

For machining characteristic of composite we have taken the drilling process by using CNC machine centres and we are using the following levels that are mentioned in the below Table.1, that are used for making the holes at different speeds, feeds at same diameters. So that we can observe at what conditions it will withstand the capacity of machining conditions which means that at what speeds, feeds, and diameter it will withstand the capacity.

Fig5:Machining of composite specimens

test/ Parameter	Speed	Feed	Diameter
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2
Levels	1	2	3
Speeds	1000	1500	2000
Feeds	100	200	300
Diameter	5	5	5

Table1: Levels of the variables used in the experiment and Orthogonal array design.

III. RESULTS

3.1. Tensile strength & Tensile Modulus

It has been observed that composites with particle reinforcement treated with NaOH showed more Tensile strength & Modulus and also observed tensile strength is increasing up to 12.5% fiber and then decreases. And the variation in tensile modulus with respect to fiber weight fraction. It is observed that the tensile modulus which is an indication of load bearing capacity increases with fiber weight fraction.

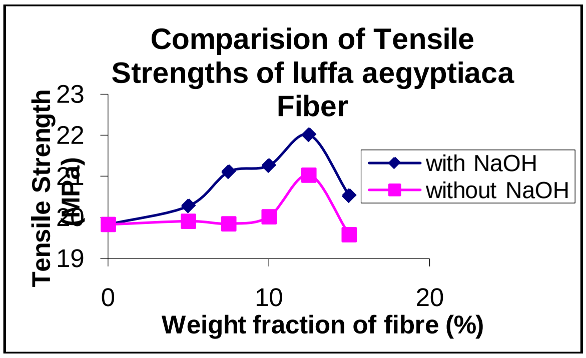

Fig6: Shows the Tensile Strength of luffa Fiber

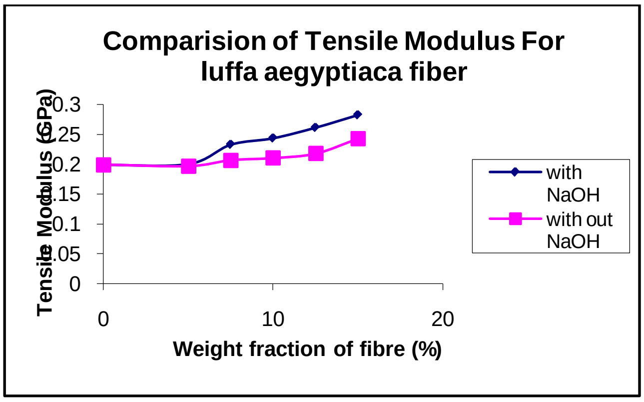

Fig7: Shows the Tensile modulus of luffa Fiber

3.2. Flexural strength & Flexural Modulus

It has been observed that composites with particle reinforcement treated with NaOH showed more Flexural strength & Modulus.Flexural strength is increasing up to 10% fiber and then decreases, and the flexural modulus increases with fiber weight fraction.

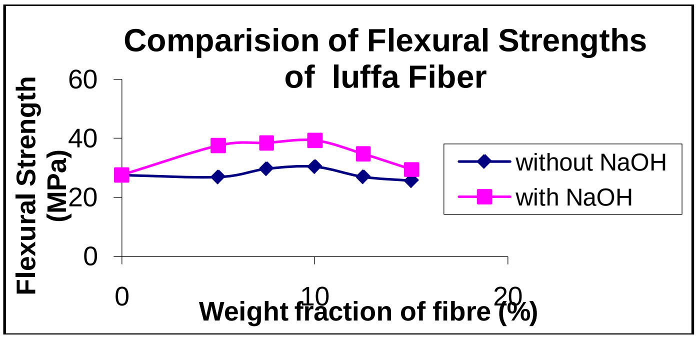

Fig8: Shows the flexural Strength of luffa Fiber

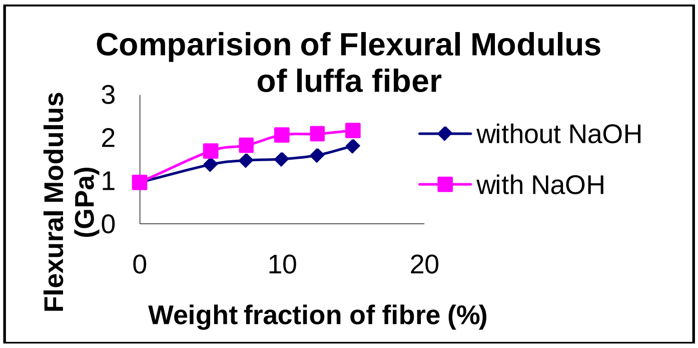

Fig9: Shows the Flexural modulus of luffa Fiber

3.3. Impact Strength

It has been observed that composites with particle reinforcement showed more Impact strength at 7.5%of fiber weight, and the impact strength is more NaOH treated composite.

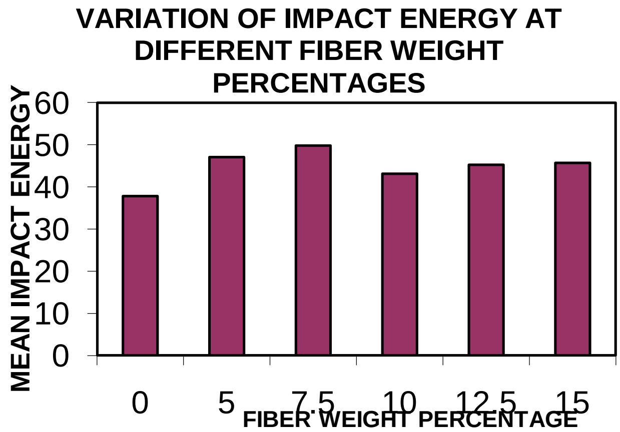

Fig10: Shows the Impact Strength of luffa Fiber

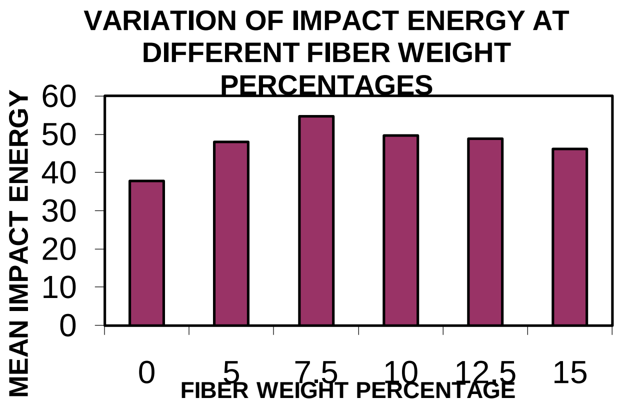

Fig11: Shows the Impact Strength of luffa Fiber treated with NaOH

3.4.Wear

It is observed that as the load increases the coefficient of friction decreases and the coefficient of friction increases upto 10% fiber weight.

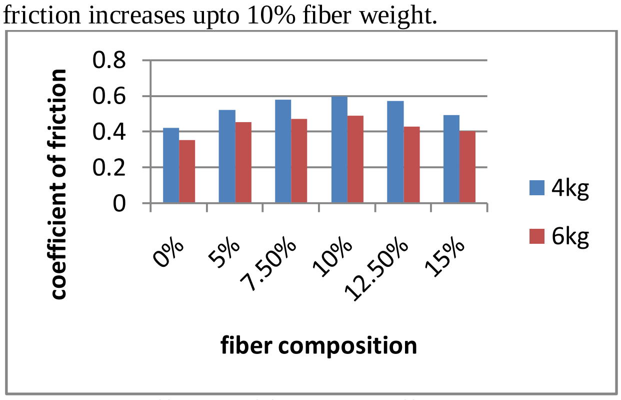

Fig12: coefficient of friction at different loads and composition at 100cm/s velocity

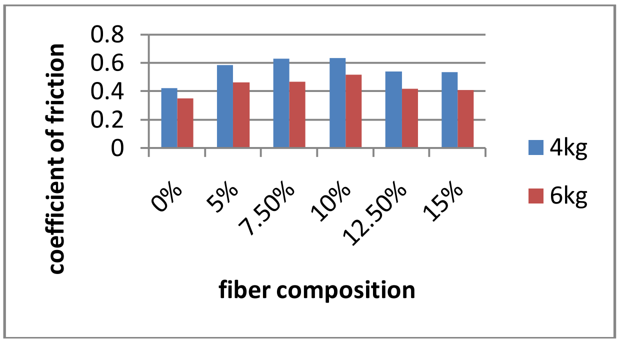

Fig13: coefficient of friction at different loads and composition at 100cm/s velocity treated with NaOH

3.5. Machining of Composite

For machining of composite we have taken the drilling process by using CNC machine centre we have taken the following parameters and mentioned in the above table1 and we have been observed that that we are adding the more amount of fiber in each composition of the plate the following parameters has minimising the machining conditions.Taguchi method is used to determine the desired optimum cutting parameters.

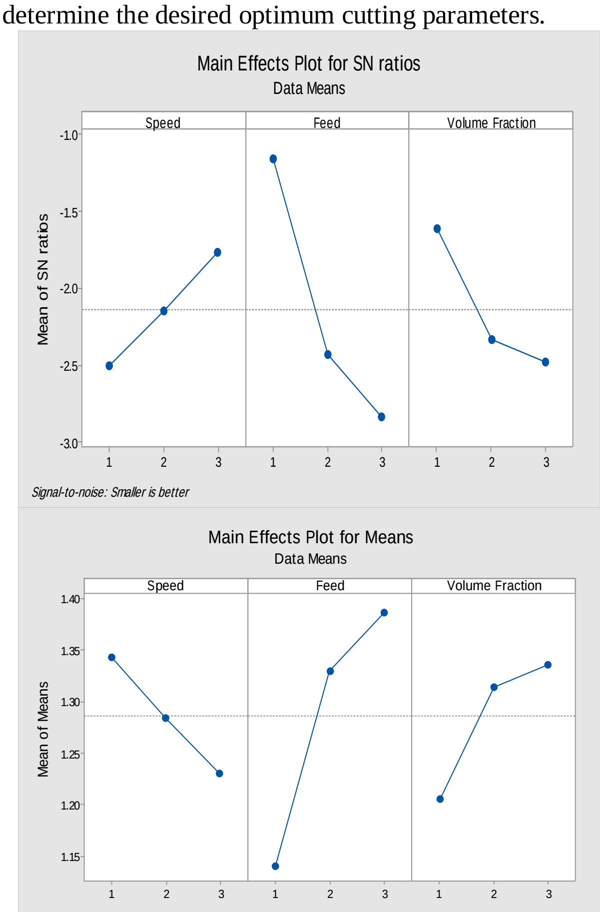

Fig14:shows the optimum cutting parameters

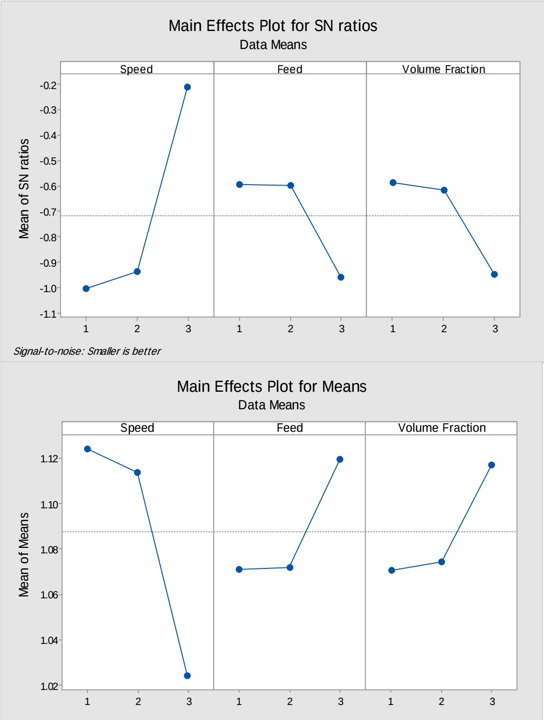

Fig15:shows the optimum cutting parameters for composite treated with NaOH

IV. CONCLUSIONS

The conclusions has been given by conducting the above tests and obtained graphs.

- The tensile strength is increasing up to 12.5% fiber and then decreases,and the tensile strength of 12.5 weight percentage of luffa aegytiaca fiber reinforced composites is 21.04MPa,The tensile strength with NaOH treated are 22.01MPa and The tensile strength of the pure poly propylene is calculated as 19.83MPa.The tensile strength is increased by 9.9% by giving NaOH chemical treatment.
- The tensile modulus of the pure poly propylene is calculated as 0.1993GPa, tensile Modulus with out treatment is 0.2425GPa,and the maximum tensile Modulus is obtained with NaOH treated is 0.2825GPa,the tensile modulus which is an indication of load bearing capacity increases with fiber weight fraction.
- The Flexural strength is increasing up to 10% fiber and then decreases.The Flexural strength & Flexural modulus of the pure poly propylene is calculated as 27.546MPa &0.965GPa,The Flexural strength & tensile Modulus with out treatment are 30.371MPa & 1.805GPa,and treated obtained as 39.318MPa & 2.165GPa.The flexural strength is increased by 29% by giving NaOH chemical treatment.
- The impact strength of pure polypropylene is 37.77778J/m and without treatment is 49.77778J/m,and composite treated with NaOH is 54.77778J/m.The impact strength is increased by 31% by giving NaOH treatment.
- The coefficient of friction is increased up to 10% and then decreased,The coefficient of friction without treatment at 4Kg is 0.596& at 6Kg is 0.488,and treated with NaOH treatment at 4Kg is 0.634& 6Kg is 0.516.
- The reduced Delamination factor for untreated composite plate is analyzed by using Taguchi method the optimization speed is 6000r.p.m,feed is1000 m/min and nose radius is 5mm.
- The reduced Delamination factor for treated composite plate is analyzed by using Taguchi method the optimization speed is 6000 r.p.m, feed is 1000 m/min and nose radius is 5mm.

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