International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

A STUDY ON TRIBOLOGICAL PROPERTIES & MOISTURE ABSORPTION OF VARIOUS POLYMER COMPOSITES MADE OUT OF VARIOUS NATURAL FIBERS & FILLER MATERIALS: A Review

Krishna Laxmana Hosur[1], Dr. T. Madhusudhan[2], Bhanuprakash N[3]

[1] *Mechanical Department, M. Tech student, Machine Design, SJBIT Bengaluru, India.*
[2]*Head of the Department, Department of Mechanical, SJBIT Bengaluru, India.*
[3] *Assistant professor, Mechanical Department SJBIT, Bengaluru, India.*

Abstract - *The main aim of this work is to estimate and understand the effect of different natural fibers and filler materials that are used in fabrication of polymer composite material. The work is to analyze the experimentally verified results with different properties like tribological behavior and moisture absorption. In this work different polymer composites are prepared with natural fibers like Jute, Bamboo fibers, Hemp, Sisal, Coir, Rice husk, Sugar cane bagasse, Kneaf, Flax etc. and filler materials like Sic, Fly ash, WC, Alumina, Silicon oxide etc. Hence an attempt is made to compare and analyze some of these experiments.*

Keywords: Polymer composite materials, Natural fibers and filler materials.

1. INTRODUCTION

Now a days researchers showing interest on the polymer composite materials because of less weight, low cost, easy to fabricate compared to monolithic materials. The composite materials are fabricated based on the matrix, reinforcement and fillers. The matrix are of 3 types, they are polymer matrix composites, metal matrix composites, ceramic matrix composites. Polymer composite materials fabrication is based on the reinforcement and matrix materials. Natural fibers and synthetic fibers are the reinforcement materials for the polymer composite materials. Natural fibers are used as reinforcement in PMC. Reinforcing materials gives the strength and stiffness of the composite materials.

1.1 Fibers

Natural fibers and synthetic fibers are the two types of fiber reinforcement materials for the polymer composite materials. Naturally available fibers are called as natural fibers. The different polymer composite are prepared with natural fibers like Jute, Hemp, Kneaf, Coir, Rice husk, Bamboo, sisal etc. The utilization of natural fibers for the fabrication of polymer composite materials because abundantly available in nature, less cost, less weight and gives better strength and stiffness of the composite material.

1.2 Fillers

Natural fibers and filler materials reinforcement of polymer composite materials. The filler materials used to enhance the strength of polymer composite materials. Filler materials that are used to increase the strength and reduce the fabrication cost of composite materials. The filler materials like Sic, Fly ash, WC, Alumina, Silicon oxide etc. that are used to increase the mechanical properties of composite materials.

2. LETERATURE SURVEY

Emadi Omarani et al, in this experimental work is to study the tribological behavior of the reinforced polymer composite materials. And the effect of moisture content present in the natural fibers which will affect on the tribological behavior of polymer composite materials. The work conclude that the moisture content natural fibers have higher material loss comparatively chemical treated materials [1]. T. Madhusudhan et al, in this investigation carried out on the tribological behavior on Hybrid polymer composite materials. On this study of filler material sic is used for the hybrid polymer composite like Glass-Jute-Epoxy, Glass –Sisal-Epoxy and Glass-Rubber-Epoxy composites with different weight percentage of silicon carbide filler material to analyse the tribological behavior of composite materials. The work conclude that the unfilled hybrid polymer composites have high material loss compared to the sic filled hybrid polymer composite materials [2]. Temesgen Berhanu Yallew et al, in this investigation on tribological behavior on jute reinforcement of polypropylene composite material. In this investigation the effect of Jute fiber reinforcement on the resulting composites behavior under friction. The wear behavior of composite material was analyzed based on the different working parameters like speed, load, and sliding distance. Based on the wear behavior the SEM has been utilized to support the discussion of outcomes [3]. T. Madhusudhan et al, in investigation of work to study the tribological behavior of polymer composite materials. Two body abrasive wear test carried out at different loading and abrading distance for hybrid polymer composite materials. The test to be conducted by using pin-on-disc wear testing apparatus is used to find the surface hardness and strength and stiffness of sic filled Glass fiber reinforced with epoxy resin hybrid composites. The addition of filler material sic to the hybrid composite material will decrease the wear rate and increase abrading distance. [4]. Layth Mohammed et al, in paper the affect of chemical treatment for the natural fibers reinforcement of polymer composite materials. The moisture absorption properties of natural fibers can be

reduced by the chemical treatment. The chemical treatment of the natural fibers improves the adhesion between the natural fiber and polymer composites [5]. K. Alagarraja et al, in this investigation of carried out on the Hybrid composite materials like sisal- GFRP composite. The study on mechanical properties of hybrid composite materials [6]. Shreenidhi C H et al, in this investigation was carried to evaluate tribological characteristics of composite materials and its properties of composites to analyse the different parameters affecting to wear characteristics [7].

3. RESULTS AND DISCUSION

From the above literature survey a study on tribological properties & moisture absorption of various polymer composites made out of various natural fibers & filler materials.

3.1 The tribological behavior of various polymer composites made out of various natural fibers & filler materials.

- For Tribological behavior, wear and friction are the two important phenomena during relative motion of solid surfaces. The wear behavior of composite material was analyzed based on the different working parameters like speed, load, and sliding distance. According tribological behavior of jute/epoxy composite materials are compared with addition of sic & Alumina filler materials to the Jute/epoxy reinforced materials. According to tribological test at constant sliding distance of 1800m, load 50N, sliding velocity 3m/s, where the value of mass loss of jute/epoxy material is $21.8*10^{-3}$g , while comparing the wear loss by addition of filler material sic & Al2O3 and jute/epoxy reinforcement to make hybrid polymer composite materials. The wear loss in the presence of 15%wt of Al2O3 with jute/epoxy materials is $2.9*10^{-3}$g. And the wear loss in the presence of 15%wt of sic with jute /epoxy materials is $3.3*10^{-3}$g. Addition of 15% of Sic and Al2O3 with jute/epoxy materials shows the less mass loss compared to jute/epoxy composite material.

combination	Wear loss
Jute + Epoxy	$21.8*10^{-3}$g
Jute+ Epoxy+ 15%of Al2O3	$2.9*10^{-3}$g
Jute+ Epoxy+ 15% of sic	$3.3*10^{-3}$g

Table.1. Wear loss of jute/epoxy composite materials with different filler materials.

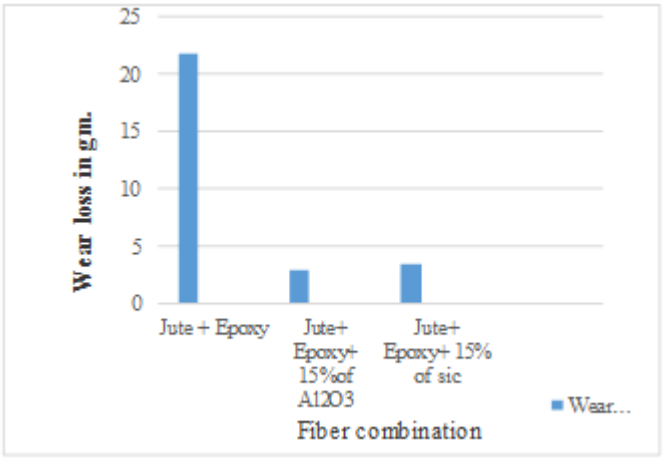

Fig.1. Wear loss v/s fiber combination for constant velocity of 3 m/s, constant load of 50N: (a) for Al2O3 and (b) for Sic.

- According tribological behavior of jute/polypropylene composite materials. Jute/polypropylene composite materials compared with the neat polypropylene materials under different loading condition.

combination	Different loads in N	Specific wear rate in mm^3/Nmm
Neat polypropylene	10	3.2E-07
Neat polypropylene	20	2.6E-07
Neat polypropylene	30	2.4E-07
Jute + polypropylene	10	9E-08
Jute + polypropylene	20	7.5E-08
Jute + polypropylene	30	4E-08

Table. 2. Specific wear rate at different load in N for (a) neat PP; (b) Jute/PP

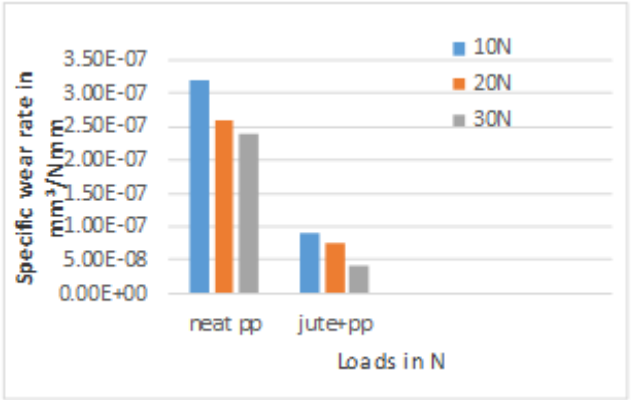

Fig.2. Specific wear rate v/s load results of the jute/polypropylene composite materials.

SEM analyzed results for JUTE + Polypropylene.

According tribological behavior of jute/polypropylene composite materials. SEM Micrographs of worn Jute/ PP composite specimen at different load &sliding distance. a)10N and 3m/s; b)20N and 2m/s; c) 30N and 1m/s.

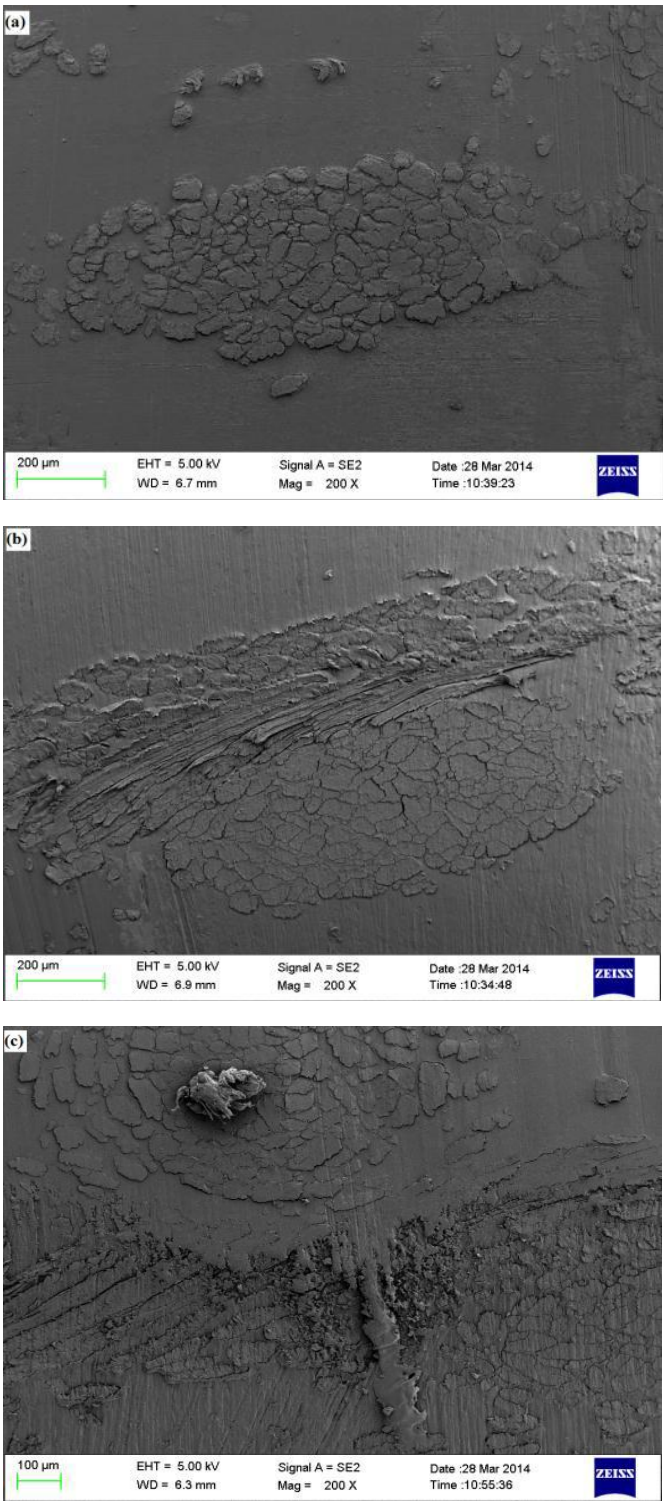

Fig 3. SEM Micrograph of worn Jute/ PP composite specimen at a)10N and 3m/s; b)20N and 2m/s; c) 30N and 1m/s.

- According tribological behavior of sisal/polysulfide – modified epoxy composite materials. Tribological properties of sisal reinforced composites under different orientation of natural fibers in the composite. The specific wear rate with constant load 7N and sliding speed of 2.5 m/min for sisal fiber under different orientations reinforced polysulfide- modified epoxy.

Combination	Fiber orientation	Wear rate (mm^3/ $Nm*10^{-13}$)
Sisal + polysulfide-modified Epoxy	Normal	0.4
	Parallel	1.3
	Anti-Parallel	0.6

Table. 3. The wear rate for sisal/polysulfide –modified epoxy composite materials under different orientation.

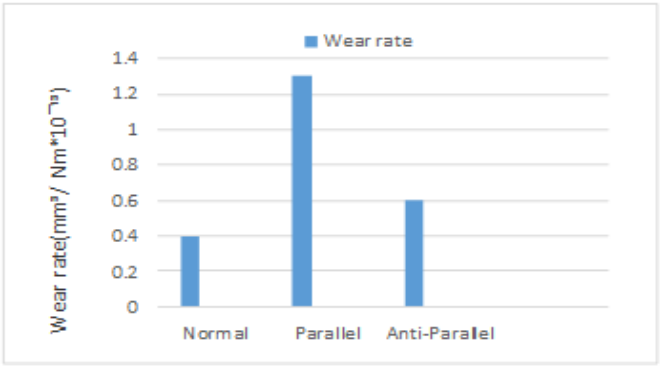

Fig.4. wear rate v/s load results for sisal/polysulfide – modified epoxy composite materials under different orientation

SEM analyzed results for sisal and polysulfide-modified epoxy composite

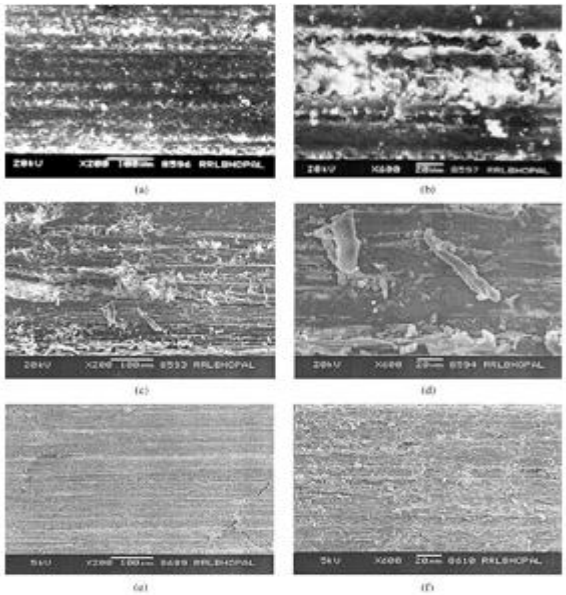

Fig. 5. SEM micrographs of worn surface of different composites:

(a) Worn surface of epoxy sample at 7 N load;

(b) Magnified view of worn surface of epoxy sample at 7N load;

(c) Worn surface of longitudinal fiber direction sample at 7 N load;

(d) Magnified view of worn surface of longitudinal fiber direction sample at 7 N load;

(e) Worn surface of normal orientation sample at 7 N load showing interface filled by fine debris;

(f) Magnified view of worn surface of normal orientation sample at 7 N load

3.2. The moisture content of different natural fibers:

From the investigation, the equilibrium moisture content of different natural fibers at relative humidity & room temperature.

Sl. No	Natural fibers	Equilibrium state of moisture content at 65% relative humidity.
1	Flax	9.1
2	Hemp	9.0
3	Wood	6.6
4	Sisal	11
5	Jute	12
6	Coir	10
7	Bamboo	8.9

Table.4. the equilibrium moisture content of different natural fibers.

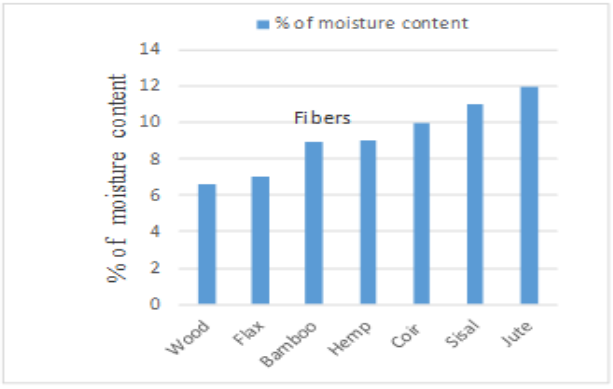

Fig.6. %of moisture content in the natural fibers

Different chemical treatment to be done for the Reduction of moisture content in various natural fiber polymer composites. Acetic anhydride (AC), Propionic anhydride, Acetylene, Alkali, Latex coating, Peroxide treatment, Maleic anhydride (MA), Styrene (S), Acrylic acid (AA) and isocyanate treatment on the moisture absorption properties. This conclude that all the chemical treatment causes the reduction of moisture absorption properties in all temperature.

SEM analyzed results for Jute fiber.

SEM images showing the difference of untreated and alkali chemical treated jute fiber. The surface of untreated samples shows some trapped foreign substances on the surface of jute fiber before chemical treatment. While after the chemical treatment, the surface of jute fiber did not show any foreign substances. From the literature review chemical treated jute fiber is having more bonding strength comparative to the untreated jute fiber.

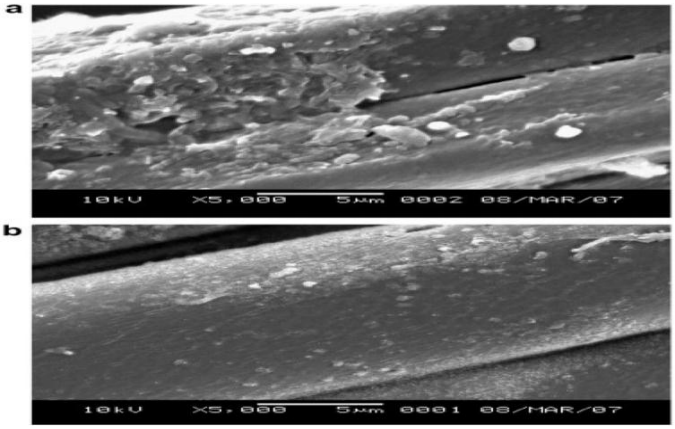

Fig. 7. SEM images showing the difference of untreated and alkali chemical treated jute fiber.

4. CONCLUSION

From the above results and discussion of Tribological Properties & Moisture Absorption of Various Polymer Composites.

- The tribological behavior of unfilled hybrid polymer composites have high material loss compared to the sic filled hybrid polymer composite materials.
- According to tribological test the maximum weight loss of jute/epoxy is $21.9*10^{-3}$g. The addition of 15% of Sic and Al2O3 with jute/epoxy materials then the wear loss in the presence of 15% of Al2O3 with jute/epoxy materials is $2.9*10^{-3}$g. And the wear loss in the presence of 15% of sic with jute /epoxy materials is $3.3*10^{-3}$g. . Addition of 15% of Sic and Al2O3 with jute/epoxy materials shows the less mass loss compared to jute/epoxy composite material.
- SEM analyzed photographs for jute and sisal under different parameters are studied.
- SEM images showing the difference of untreated and alkali chemical treated jute fiber. Chemical treated jute fiber is having more bonding strength comparative to the untreated jute fiber.

5. REFERANCE.

[1]. Emad Omarani, Pradeep L. Menezes, Pradeep K. Rohatgi, State of the art on tribological behavior of polymer matrix composites reinforced with natural fibers in the green materials world – a review, Engineering Science and technology, an International Journal 19(2016) 717-736.

[2]. T. Madhusudhan, Dr. M. Senthil Kumar, Investigation on Wear Resistance Behavior of Sic Filled Hybrid Composites, International Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 2, February 2017, pp. 82_92 article ID: IJMET_08_02_010.

[3]. Temesgen Berhanu Yallew, Pradeep Kumar, Inderdeep Singh, 12th global congress on manufacturing and management, GCMM2014, Sliding Wear Properties of Jute Fabric Reinforced polypropylene composites, Procedia Engineering 97(2014) 402-411.

[4]. T. Madhusudhan, M. SenthiL Kumar , Experimental study on wear behavior of Sic filled hybrid composites using taguchi method, International Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 2, February 2017, pp. 271–277 Article ID: IJMET_08_02_033.

[5]. Layth Mohammed, M.N.M. Ansari, Grace Pua, Mohammad Jawid and M. Saif Islan, A Review on Natural fiber reinforced Polymer Composite and Its Application, Hindawi Publishing Corporation, International Journal of Polymer Science, Volume 2015, Article ID243947.

[6]. K. Alagarraja, Dhamodharam, K. Gopinathan, R.Mathan Raj, K.Ram Kumar, Fabrication and testing of fiber reinforced polymer composite material, ISOR Journal of Mechanical and Civil Engineering (ISOR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X.

[7]. Shreenidhi C H, Bhanuprakash N, Tribological test of polymer composite material with different filler materials, international Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 04 | Apr -2017, e-ISSN: 2395 -0056, p-ISSN: 2395-0072