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ACETYLATION CHEMICAL TREATMENT FOR IMPROVE THE SURFACE OF NATURAL FIBER

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ABSTRACT

The world is moving forward in a high speed. In this fast phase world we have to carry many things along with us which are much higher and easy to carry. Due to portability reason, we prefer plastic and the damage and loss will be minimal. Do we know consequences of using plastics? It is the most dangerous substance to the environmental pollution. We take comport and leave a curse to the next generation. The green gases emitted by plastics in the long run will pollute the environment. It is time to fix an alternative to the plastics. We have found out natural fiber as the suitable replacement. The natural fibers have as low density, high strength and stiffness, natural fiber reinforced composite matrices have found a large dispersal in several areas of technical applications. Even though it has drawback in the adhesion between the fiber and matrix. By using suitable chemical treatment to achieve the better roughness of the surface it will improve the contact between the fiber and matrix.

KEYWORDS - Sisal, Composite, Acetylation

1. INTRODUCTION

Natural fibers were used for reinforcing the matrix until early in the mid-20th century. Since

1950 there was an increased demand for the stronger, stiffer, light weight composites in the field such as aerospace, transportation and construction. This leads to the incorporation of high performance fibers for reinforcement. Because there newer composites having low specific gravity, superior strength and modulus like metals (1,2).Composite are those material made up from two or more distinct materials having different chemical and physical properties provide a well-defined structure (3). Natural fibers are subdivided based on their origins, coming from plants, animals, or minerals. It offers an alternative to the synthetic fibers due to their low cost, low density and biodegradability. Here Sisal fiber is natural fiber. fiber and polymer is matrix of the composites.

A better understanding of fiber-matrix interface and the ability to transfer stress from the matrix to the fiber is necessary for developing natural fiber-reinforced composites. Chemical treatments are considered in modifying the fiber surface properties because it can enhance the bond strength between fiber and matrix. Due to differential hydroxyl group and also can reduce water absorption of the natural fiber. Chemical treatments of natural fibers were investigated by a number of researchers. Natural fibers are better than man made because of their low cost, low density, recyclability and biodegradability (4-6). Natural fiber reinforced composites can be used in the plastics, automobile and packaging industries (7).

The composition of Sisal fiber is basically of cellulose, lignin and hemicelluloses. The natural fiber of sisal it has the chemical content as following Cellulose 65 (wt%), Hemicellulose 12 (wt%) ,Lignin 9.9 (wt%), Waxes 2 (wt%). Here the cellulose content is much more, compare to the other natural fiber. It is help to improve the strength of natural fiber. Here the Acetylation chemical treatment suggested for the surface modification of natural fiber. The failure strength and the modulus of elasticity and length of the break depend on the amount of cellulose and the orientation of the micro-fibers. As a natural product these characteristics have a wide variation from one plant to another. The Sisal fibers are found commercially in several formats: fabric, cords, strips, wire, rolls,

(a) Sisal leaf (b) Sisal fiber

2. ACETYLATION CHEMICAL TREATMENT

Acetylation describes a reaction introducing an acetyl functional group ($CH_3COO–$) into an organic compound. Acetylation of natural fibers is a well-known esterification method causing plasticization of cellulosic fibers. The reaction involves the generation of acetic acid (CH_3COOH) as by-product which must be removed from the lignin and hemicellulose material before the fiber is used. Chemical modification with acetic anhydride (CH_3-C(=O)-O-C(=O)-CH_3) substitutes the polymer hydroxyl groups of the cell wall with acetyl groups, modifying the properties of these polymers so that they become avoid the water (11). The reaction of acetic anhydride with fiber is shown as (11)

$$\text{Fiber-OH}+CH_3\text{-C(=O)-O-C(=O)-}CH_3 \rightarrow \text{Fiber-OCO}CH_3+CH_3COOH \quad (1)$$

Acetylation can reduce the water absorption nature of natural fibers and increases the dimensional stability of Composites. Acetylation was used in surface treatments of fiber for use in fiber-reinforced composites (8, 10, 11, 12). Acetylation treatment of sisal fiber was reported to improve the fiber–matrix adhesion. The procedure included an alkaline treatment initially, followed by acetylation. Mishra et al. (9) investigated the acetylation of sisal fibers. Dew axed sisal fiber was immersed in 5 and 10% NaOH solution for 1 h at 30°C; the alkaline-treated fiber was soaked in glacial acetic acid for 1 h at 30°C; it was decanted and soaked in acetic anhydride containing one drop of concentrated H_2SO_4 for 5 min. Nair et al. (13) treated raw sisal fiber in 18% NaOH solution, then in glacial acetic acid and finally containing two drops of concentrated H_2SO_4 for a period of 1 h. The treated surface of sisal fiber reportedly became very rough and had a number of voids that provided better mechanical interlocking with the polystyrene (PS) matrix. A hypothetical model of interface between the sisal fiber and PS composites has been postulated. Meanwhile, the thermal stability of treated fiber composites was found to be higher than that of untreated fiber composite because of better thermal stability of treated fibers and improved fiber–matrix interactions in treated fiber composites (13). It was also reported that acetylated natural fiber-reinforced polyester composites exhibited higher bio-resistance and less tensile strength loss compared to composites with silage treated fiber in biological tests (14).

3. MATERIAL PREPARATION

The mold box was made with the dimension of 200 mm (L) ×150 mm (W) ×3.0mm (T) mm. The matrix was prepared by mixing the hardener to polyester resin. The polyester and fiber ratio was maintained at 10:1.To get the well-cured and a standard-quality specimen, the polyester and hardener must be mixed smoothly and slowly. Initial layer of the mold was filled with polyester resin mixture and then the appropriate quantity of fibers was placed such

that polyester mixture completely spread over the fibers. Before applying compression, efforts were made to remove all bubbles with roller. Finally, the compression pressure was applied evenly to achieve the uniform thickness of 3 mm and cured for 24 h at room temperature. The obtained composite plates are of the size (200 ×150×3) mm^3.

(a) Specimen at pure resin

(b) Specimen at 1%fiber 99% resin

(c) Specimen at 2% fiber 98% resin

(d) Specimen at 3% of fiber 97% resin

4. TESTING OF THE COMPOSITES

4.1.1 Tensile test

The composite specimens were tested as per ASTM standards. Tensile testing was done as per (ASTM D 3039-76) with the help of (INSTRON-3369) model Universal Testing Machine at a cross head speed of 10 mm/min. The temperature was conditioned at 220C with the humidity of 50%. The specimen dimensions were (150×15×3) mm^3.

4.1.2 Flexural test

Flexural testing was done as per (ASTM D 5943-96) standards using three point bending method at a crosshead. The load was placed midway between the supports. Speed of 5 mm/min and at a temperature of 220°C with the humidity 50%. The specimen dimensions were (100 ×15 ×3) mm^3. (INSTRON-3369) model Universal Testing Machine is specially designed for the automated material testing of polymer composites by INSTRON Corporation.

Flexural strength $\sigma f = 3PL / 2bd^2$ (3)

Flexural modulus: $E f = L3m / 4bd^3$ (4)

L (mm) is the length of span; b is the width of the specimen; d is the thickness; P (N) is the maximum load and m is the slope of the initial straight line portion of the load–displacement curve.

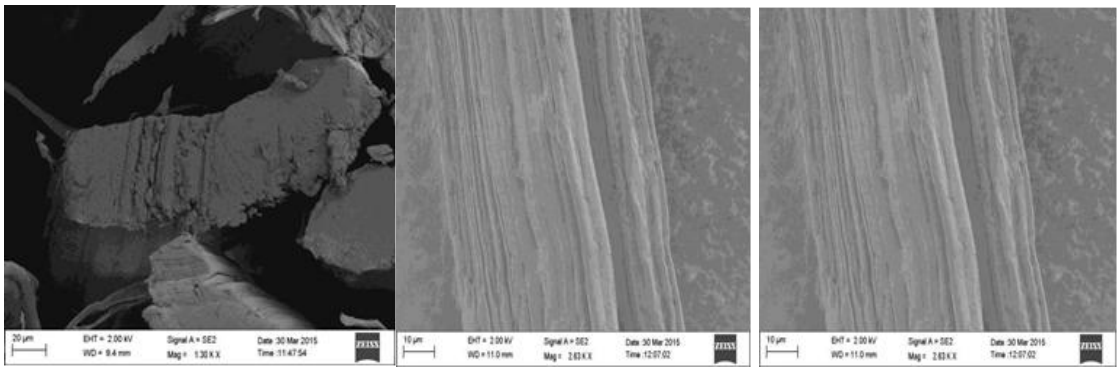
4.1.3 Impact Test

The impact testing was done as per (ASTM D 256-88) by Izod impact machine with unnotched specimen. The specimen dimensions were (122 ×13 × 3) mm^3. In each case, five samples were tested and the average values were reported.

5. RESULTS AND DISCUSSION

5.1. SEM Analysis

Scanning electron microscopic (SEM) provide an excellent technique for the study of surface morphology of raw and chemically modified sisal fibers. It has been observed that surface of raw sisal fibers differs in smoothness and roughness than chemically treated sisal fibers. These micrographs clearly showed the difference in their surface morphology. The raw fiber, surface is very smooth in comparison to treated fibers.



(A) (B) (C)

The above scanning electron microscope image. Is explaining the contact between fiber and matrix. The image (a.) shows the fiber and matrix have a good contact between each other, (b.) The SEM photomicrograph of the surface of sisal fiber interior. (c) After treatment it is shows the longitudinal of the fiber. It has good surface finishing after the treatment. The micro level test (10µm) range show the curing better in both fiber and matrix, Finally the SEM image is proving the composite is well curing.

6. TESTING REPORT

6.1 Before chemical treatment

% of Fiber	Tensile Test (N)	% of Elongation	UTS (N/mm^2)	Flexural strength (Mpa)
5	34.67	1.3	14.75	193.08
10	2.408	1.052	17.048	169.33
15	263.78	1.6	18.943	223
20	725.35	3	24.89	216.95
25	528.47	2.0612	19.407	295.48

6.2 After chemical treatment

% of Fiber	Tensile Test (N)	% of Elongation	UTS (N/mm^2)	Flexural strength (Mpa)
5	39.485	1.6	16.255	203.27
10	2.806	1.517	18.737	175.33
15	279.21	1.5	19.914	263.06
20	761.07	3.233	28.371	237.23
25	567.21	2.2	21.739	323.47

The above result ,when compared this it is very easy to identify the performance in the fiber due to acetylation chemical treatment.in that straight line will explain the tensile strength is increased in the expected range.it explain the load carrying is more. Even though the mechanical property of the fiber is increase.

7. CONCLUSIONS

Sisal fiber has been treated with Acetylation in order to analyses its modified properties. This study showed an increase in strength in case of treated fiber composite when Tensile strength is studied. This may be due to the increased fiber matrix adhesion which is detail report by SEM analysis. This confirms the surface modified characteristics of the chemical treated fiber which is due to the decrease in the amount of lignin, hemicellulose and impurity from the surface of the fiber. This treatment leads to the fibrillation which causes the breaking down of the composite fiber bundles into smaller fibers. So a better adhesion between the fiber and matrix occurred. Acetylation treatment can be done for improving the

mechanical properties of the sisal fiber composite. SEM photomicrographs demonstrated the interfacial interaction between sisal fibers and unmodified polyester resin, natural fibers are important renewable resources in many countries and natural-fiber-based polymer composites form a new class of materials, which have good potential as future substitutes for scarce wood, therefore providing a solution to environmental issues such as reduction of both synthetic and agricultural wastes.

8. REFERENCES

[1]. Jindal R, Kaith BS, Mittal H, and Sharma R Advances in Applied Science Research, 2 (2):19-27

[2]. Van Voorn B, Smit HHG, Sinke RJ, de Klerk B. Compos A: Appl Sci Manuf., 32:1271(2001).

[3] Van de Velde K, Kiekens P. J Appl Polym Sci., 83:2634 (2002)

[4] Frederick TW, Norman W. Natural fibers plastics and composites. Kluwer Academic Publishers

[5] Sreekala MS, Thomas S (2003). ComposSci Technol 63(6):861

[6]. Mishra S, Mohanty AK, Drzal LT, MisraM, Parija S, NayakSK, Tipathy SS (2003).

[7]. Paul A, Joseph K, Thomas S (1997). Compos Sci Technol 57(1):67

[8]. Muhammad P, Mohini MS. ResourConserv Recycl., 39:325 (2003).

[9] Clyne TW, and Hull, D., Introduction to composites materials," 2nd edition (1996)