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Characterization of Phoenix fiber and its Composites

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Abstract: The natural fibers play a major role as reinforcement in composites due to their important properties like lightweight, biodegradability and non-toxicity. Phoenix fiber is one as such type possessing high cellulose which is inexpensive and available plenty. The present experimental study aims at learning the mechanical behaviour of natural fiber composites. The phoenix fibers were extracted and its physical, chemical and mechanical properties such as density, diameter, cellulose, lignin, wax and tensile force were experimentally determined. The Fourier Transform Infrared Spectrometry (FTIR) and Scanning Electron Miscroscope (SEM) revealed the existence of chemical compounds and impurities of raw fiber. The results show that 20 mm fiber length has maximum tensile strength when compared to 30, 40, 50 and 60 mm respectively. Also, the fiber has more cellulose contents when compared to some existing natural fibers. Hence, it conform the suitability of this fiber as a potential reinforcement in polymer composites.
Keywords: Phoenix fiber, Characterization, Composites.

1. Introduction and Experimental

The consumption of natural fibers in composite laminates rises day by day because they are richly available, biodegradable, inexpensive and eco-friendly in nature. Tensile tests were performed on a microforce testing system using four different gage lengths. The effects of fiber lengths on tensile properties such as strength, modulus, and elongation at break, corrected compliances and Young's modulus have been investigated. The aim of physical analysis is to analyses the cross-section of fibers, their microstructural characteristics and density of the fiber. The chemical analysis is used to find lignin, cellulose, wax, ash and moisture contents [1].

Single fibre tensile tests were performed in order to obtain their mechanical properties. The results of the thermal and mechanical characterization, which are comparable to those of other common lignocellulosic fibres, confirm that these fibres show some potential as reinforcement in polymer matrix composites [2].

1.1. Extraction of phoenix fiber

The leaf stem is cut from the plant. After which the leaf stem are immersed in water for two weeks to remove primary and secondary walls of it by biodegradable process which will be useful to extract the fibers without any damage. It is exceptionally durable and a low maintenance with minimal wear and tear. Then the extracted fibers are dried in sunlight for 2-3 days. Final form of sun dried fibers is used for manufacturing of composites.

1.2. Physical and chemical Properties

The water displacement method was employed to find the density of the phoneix fiber. The weighed quantity of fiber was completely immersed in water and the volumetric displacement was observed. The weight to volume ratio yielded the density value. The air wedge shearing interferometer was used to measure the diameter of the phoneix fiber.

1.3. Chemical Properties

a) Wax Content

The wax content was measured with the help of sox lot apparatus. Petroleum benzene liquid was heated 70°C and one gram of phoneix fiber was immersed in the liquid. The 1h reflux time was provided and the fiber sample was dried. After drying the fiber, it was weighed and weight difference confirmed the wax content.

b) Moisture Content

The weighed quantity of phoneix fiber was placed in an oven at the temperature range of 105±2°C for 4 h. the weight of the fiber taken from the oven was measured and the difference in weight accounts for the moisture content present in the fiber.

c) Cellulose Content

The weighed quantity of phoneix fiber was immersed in a mixture of sodium chloride 1.72%, and three drops of sulphuric acid in water. One hour soaking time was provided. The residue was washed with distilled water, dried at room temperature and weighed. The percentage of cellulose was noted by the ratio of the residue weight to the dry sample weight.

d) Lignin Content

The weighed quantity of the phoneix fiber sample was immersed in a mixture of sulfuric acid 12.5 ml and 300 ml water at room temperature. Two hours reflux time was provided. The solvents were removed and residue was weighed. The residue weight was noted as the lignin content.

2. Results and Discussion

2.1. Physical Properties of Phoenix Fiber

2.1.1. Fiber Density and diameter

It was noticed that the density values of phoneix fiber were less than that of synthetic fibers and the fiber density is 1.125 g/cc. Since the natural fibers did not have uniform diameters, 20 samples of phoneix fiber were taken for testing and the fiber diameter at the ends and middle of the fibers were also measured and the fiber diameter is 0.5766mm.

2.2. Chemical Properties of Phoenix Fiber

The chemical composition of the fiber influences its properties. The cellulose content has an important influence on the mechanical properties of the natural fiber such as tensile strength, modulus, and elongation at break. The raw fiber consists of cellulose (76.13 %), lignin (4.29 %), wax (0.32 %), and moisture (10.41 %).

2.3. Fourier Transform Infrared Spectrometry

FTIR analysis was done for raw fiber and the chemical compounds were identified. Figure 1 shows the FTIR spectrum for raw fibers. FTIR spectrum of phoenix fiber shows absorption bands of various chemical groups of lignocellulose fiber components such as cellulose, hemicellulose, and lignin. The peak at 1063.27 cm^{-1} was assigned to SiAO-cellulose. This peak indicated the presence of sulphur and lignin. The band around 1607.33 cm^{-1} indicated the presence of cao stretch of acetyl group of hemicellulose.

2.4. Surface Morphology of the Phoenix Fiber

The surface morphology analysis was carried out by scanning electron microscope. The SEM images revealed that the phoneix fibers had multicellular structure. Figure 2 shows the SEM image of the raw fiber. Surface of fiber is irregular and has layer of deposits probably composed of lignin, hemicellulose and other non-cellulosic substances.

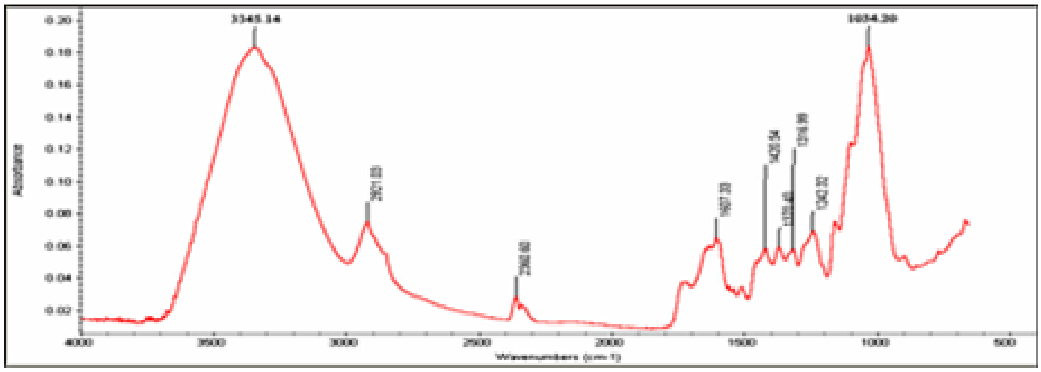

Figure 1 FTIR spectrum of raw fiber

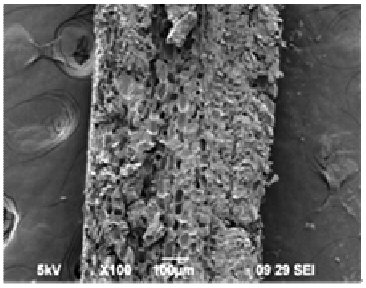

Figure 2 Micrograph of Fiber (X 100)

2.5. Tensile Properties of Fibers

A total of 20 fibers are randomly chosen from a given bundle and tested for each GL of 20, 30, 40, 50 and 60 mm. The fiber ends are hold between the pneumatic grippers and the load vs. displacement curve is measured. The increase in GL of fiber leads to more fiber displacement.

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