Webology, Volume 18, Number 5, 2021
ISSN: 1735-188X
DOI: 10.29121/WEB/V18I5/8

Moisture absorption and Impact Properties of Flax/kevlar Fiber based hybrid composites under Ambient Temperature

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ABSTRACT

Fibre-reinforced polymeric materials have a wide range of uses. Consequently, there has been a surge in curiosity about the research of coir hybrid composites. The moisture content as well as shock characteristics of a weaved flax-Kevlar biocomposite were looked into in this study. Kevlar served as the epidermal layer in all experiments, while flax was employed as the base material. The testing findings demonstrated that biocomposites with such a significant flax component had a higher population as well as a higher porous component. Results obtained were seen in the moisture absorption and slump flow tests, as the specimen having an increased flax component absorbs greater moisture and has lower dimensional space integrity. Moisture content has an influence on the fracture toughness of polymers. The fracture toughness dropped by approximately 46.53%, with the maximum applied intensity decreasing by approximately 80.36%. These results of this research are significant again for future use of weaved flaxseed in hybrid laminating composites.

Keywords: Natural Fiber; Glass Fiber; Moisture absorption; Hybrid Composites; Flax Fiber; Impact Properties.

INTRODUCTION

Technological innovations, particularly those connected to aeronautical, submarine, and industrial uses, need an unusual mix of material qualities that alloying elements and porcelain might provide. Aircraft use a considerable high mechanical strength of building components, which is not attained with construction products. Through judiciously blending a wide range of materials, hybrids enable us all to attain the necessary qualities. In general, composites have excellent mechanical properties and a high specific stiffness, which makes them attractive in a range of industrial uses that need these properties. Glass fibre biodegradable polymers as well as fibreglass polymers are employed as metal substitutes in industry sectors because they offer the desired properties. Different types come with their own set of functions as well as constraints [1,2].

Due to their reduced weight and strong handling qualities, high-efficiency reinforced polymer polymer (FRP) systems are extensively employed in the aviation, military, as well as automobile sectors. Currently, Frps are mostly constructed with synthetic glass fibre, graphite, fibreglass reinforced, and others. The benefits of fibreglass are widely recognised, including their high tensile strength, rigidity, extended failure mode, chemical resistance as well as chemical inertness, thermal conductance, and numerous others. Scientists have started looking into renewable fiber-based composites because of the high manufacturing costs, concern about hydrocarbon supplies, and increasing ecological conscience. The growing emphasis is just on the utilisation of natural materials Polymers were popular owing to their use of sustainable resources, low density, low price, and renewability. Biopolymers like muffins, grapefruit leaves, carbohydrate forearm, linseed, coconut fiber, as well as sweetener forearm were extensively researched. Furthermore, as contrasted to synthetic fibres, the application of natural materials by itself is insufficient for meeting high demands. As a result, hybridization is the best technique to create high-quality, cost-effective, as well as ecologically responsible polymers [3,4].

Instinctual nanocomposites, like glass/curia fibers, palm oil fiber/glas, biocomposites, and pineapple, have indeed been effectively researched. The following parameters influence the final characteristics of biocomposites: matrix type, total fibre concentration, proportional component volumes, fibre content, moulding technique, and fiber-matrix interaction. Even as glassware components inside the jute fibre combination with physical increased, so did the tension characteristics, according to John and Naidu. The overall volume of the composite is determined by the ratio of substrate as well as reinforcement components. Jawaid et al. investigated the effect of void ratio in empty fruit gaggle hybrids [5].

The material properties of biocomposites are influenced by water penetration. After already being subjected to humidity, excessive moisture, as well as UV absorption inside an expedited weathered environment, Abdullah et al. discovered a considerable reduction in the tensile properties of the biocomposite polycaprolactone fibre reinforced polyoxymethylene hybridization laminate. According to Law and Isha, the impact strength of a processed flaxseed fiber-filled polyester matrix was significantly increased. This is due to the expanding action of the threads, causing increased contact between the reinforcement and resin [6,7].

Heterostructures are constructed from two or more fibres combined into a matrix material. The fibres that may be used in nanocomposite include synthetic vs. synthetic, organic vs organic, and synthetic vs organic. Due to their low cost, resilience proportion, as well as manufacturability, blended polymer nanocomposites have a large use in the field of engineering. These biocomposites include an alternative for accomplishing a mixture of characteristics like rigidity, flexural, as well as resilience that solitary fibre reinforced could indeed accomplish. In addition, biocomposites outperform single-fabric composite hybrids in terms of fatigue behavior, impact strength, and crack sensibility. According to research on different mixtures of synthetic fibres, biocomposites all have properties such as good strength properties, shock resistance, higher intensity endurance, and so on [8].

The goal of the study was to evaluate the density, air voids, moisture content, and pumpability of nanocomposite at various fibre concentrations. Furthermore, the influence of moisture content on the impact resistance of biocomposites was investigated.

EXPERIMENTAL WORKS

2.1 Materials

The woven flaxseed cloth was created using only a manual loom utilising flax thread. In this work, Kevlar 130, a polymeric polyamide artificial fibre in plain woven constructions, is employed. According to the company's spec sheet, the thickness of Kevlar is 1.5 g/cm3. Flaxseed has a weight of 1.20g/cm3. The matrixes are made of fluid epoxy glue and have a hardness of 1.09g/m3.

2.2 Fabrication of composites

A manual layup technique was used to create an epoxy coating composite material of Kevlar 130 and weaved flaxseed. Braided flaxseed mixed Kevlar material was manually laid up with polymeric matrix in a hardened steel mould using a 2:1 ratio of combining adhesives and ammonia curing agent. To avoid adherence to the mold, the entire area of the moulds was coated with such a mould cavity solvent. The volumetric proportion of matrices to fibre within every biocomposite was set at around 60:40. The Kevlar to flax interwoven proportions were changed within every experiment to produce a variety of hybridization proportions. The T1 (60/40), T2 (50/50), and T3 (40/60) composites were chosen based on the Kevlar/flax weight (%) combination.

2.3 Physical characterization

2.3.1 Density

The density of a laminate was determined using a Maverick densimeter in accordance with ASTM D792 requirements. The immersed liquid contained plain water, as well as the weight, were assessed with only an electronic scale with 1 g precision. Five examples measuring 10mm X10mm were evaluated. The ASTM D 2734-94 technique was employed to identify vacancies in materials.

2.3.2 Water absorption and thickness swelling test

At ambient temperature, 3 specimens from each composition are submerged in pure water. After more than 300 hours, the different time intervals of the liquid were weighed as well as cleaned with fresh plastic wrap before even being weighed and also recorded. The mass differential was employed to compute the moisture content, which used the continuity formula.

2.4 Charpy impact test

ASTM D256 was used to construct and evaluate the impact experiment. An impact testing machine device was utilised to conduct the V-notch experiment on specimens. Five specimen pieces for every component with dimensions of 80x80 were investigated. The specimen was collision examined prior to and after the determination of moisture content.

RESULTS AND DISCUSSION

3.1 Physical properties

Figure 1 represents the physical characteristics of mixtures. For comparison, the characteristics of flax/epoxy (all flax) as well as Kevlar/epoxy (all Kevlar) are also recorded. Because Kevlar is slightly heavier than flaxseed, the thickness of the nanocomposites increased slightly even as the number of Kevlar fibres packed increased significantly. Dry density increased as flaxseed fibre concentration increased, reaching 25.67% in specimen H5. Overall void content has been reduced in all flaxseed sources of research due to the polymer encapsulating the flaxseed sheets. As per Singh et al., composite material includes a high concentration of hydrogen bonding, making it neutral as well as aqueous, while polymers are repellent [9].

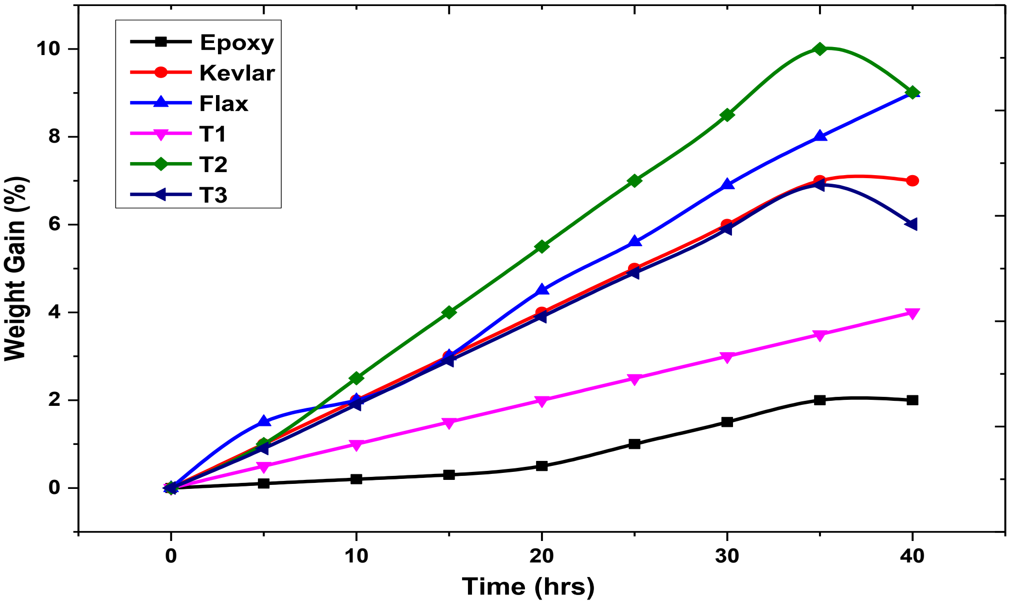

Fig.1. Weight Gain Characterises of Different Fiber Combination

Moisture was also collected by Kevlar fibre because there were many holes inside its composition. This polarity caused a hole inside the composite material contact. The inability of an adhesive resin to replenish that gas trapped inside the flaxseed clear gap as well as inside the flaxseed fibre directly contributed to the greater air voids in T3. It could also be due to intolerance between the cellulose fibres and the composite resin. Past research has indeed documented an elevation in the void ratio after flaxseed steel fibers. Consequently, the increase in fibre composition led to higher composite material densities [10].

3.2 Water absorption and thickness swelling properties

Figure 2 depicts water retention rates. In summary, the materials' water uptake performance may be described as a non-Fickian process since it grew over time but just never remained steady. It was discovered that specimens T2 as well as T3 collected 10% less liquid than the remaining specimens. The liquid limit of hybrid nanocomposites increased as the percentage of flaxseed fibre increased. Moisture content is reduced in all flaxseed compared to matrix material. It might be that the structure of epoxy primer as a moisture substrate limits the loss of fluid into the weaved flaxseed combination [11].

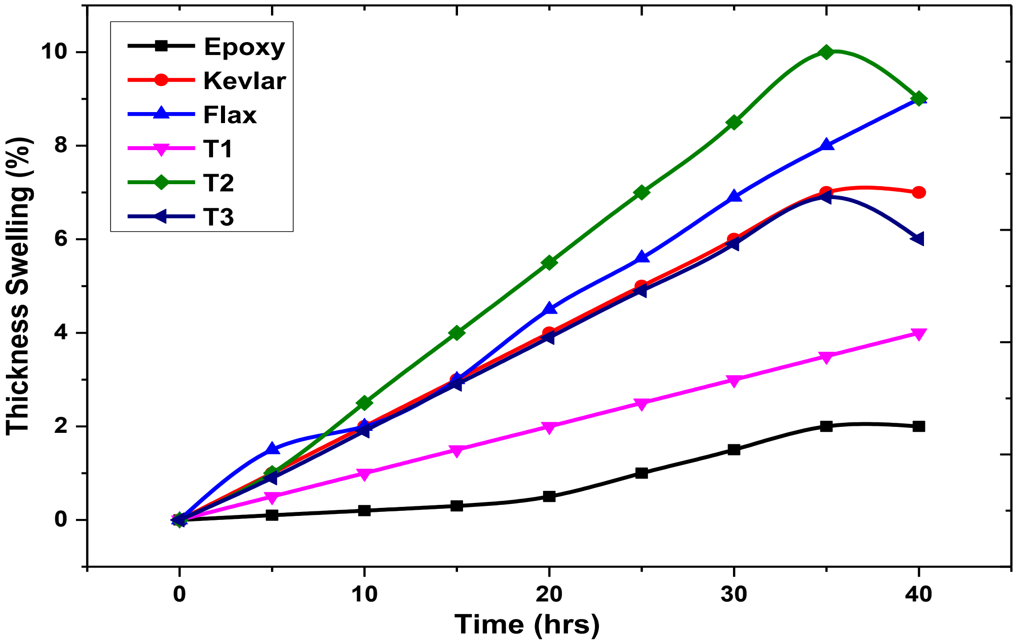

Fig.2. Swelling Thickness Characterises of Different Fiber Combination

It was discovered that specimens with a high flaxseed dietary fibre content absorbed more moisture.This occurs because water accesses the contact through tiny fissures caused by the expansion of the threads. A composite material possesses a high concentration of oxygen atoms, making it polar and fluid, while the polymer is hydrophilic. Moisture was also collected by Kevlar fibre due to the existence of holes inside its architecture. Decreased flaxseed percentage samples absorbed less moisture because of the lower moisture content of Kevlar fibers. That exposed fewer O-H compounds of a cellulosic, enhancing the program's wettability.

The existence of substantial gaps in samples T3, T5, and T6 enhanced water uptake because moisture was retained inside the spaces. In general, moisture content in composites is affected by parameters like fibre content as well as dry density. Figure 1 depicts how well the density of mixtures increases with increasing soaking time. The final findings, comparable to water uptake, demonstrate a quick rate of increase and width expansion just at the start of the experiment, but still the pace gradually decreased till it reached a predictable state. The sample's thickness of T5 plus flaxseed has increased by around 10% since the original data. Overall width inflation of the investigated composite materials rose with the proportion of natural fibre inside the hybrid, comparable to water uptake. The width inflation was halted at 11.25 for any and all flaxseed nanocomposites apart from one. This could be attributed to high fibre adhesion. Inflation of filaments as a consequence of the water uptake reduces rigidity and then also results in the creation of shear force just at contact [12,13].

3.3 Charpy impact strength

The Charpy impishness was used to evaluate the energy absorption ability of the tested concentrations. The toughness was estimated by multiplying the received impact force of the tested concentrations. The toughness was estimated by multiplying the received impact force by the specimen merge size. Figure 3 shows the shock toughness of a biocomposite after liquid absorption. Specimen H saw a 49.32% drop in impact resistance, but experiment H5 experienced a greater decline. The decline in shock characteristics of biocomposites might be attributed to nonwoven breakage caused by prolonged water exposure. As per prior studies, causing water exposure results in damage to carbon fibres, creating new pathways for moisture to infiltrate into the hybrid, therefore compromising its superfast broadband interaction. Because of gaps and permeability that damage the different fibre contacts, shock characteristics are significantly lower [14].

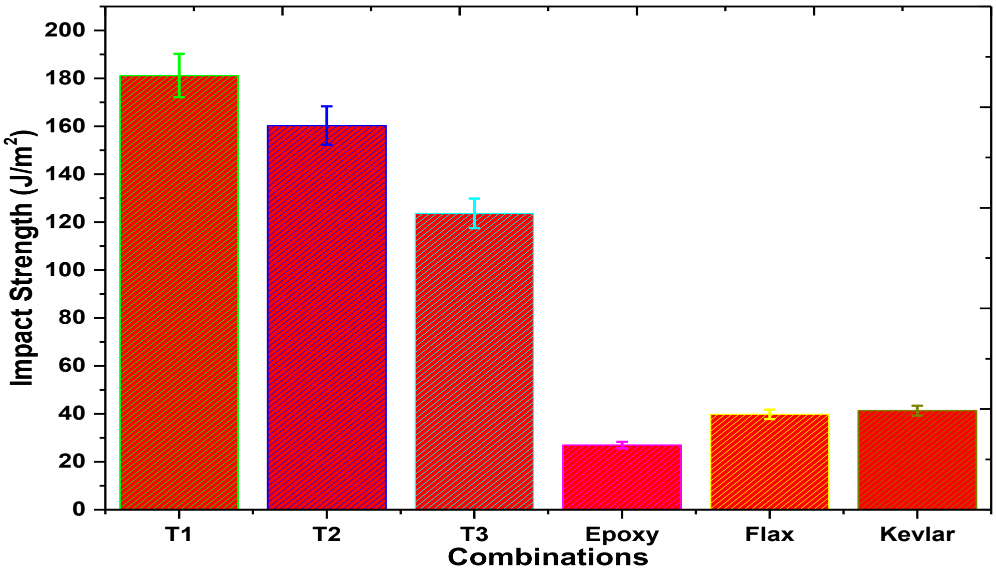

Fig.3. Impact Strength of Different Fiber Combination

CONCLUSIONS

The physicochemical characteristics of interwoven flax-Kevlar hybridization composites have been examined in this research, as well as the influence of water ingress on materials' fracture toughness. Based on the findings, we determined that the mechanical features of a material affect the water uptake and pumpability. Moisture content as well as pumpability are greater in composite samples with a greater interwoven flaxseed percentage than in other hybrids. Moisture collected either by combination was used to have a negative influence on the impact resistance of a biocomposite, which was considerably reduced following the liquid's complete evaporation.

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