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Effect of Water Absorption on Mechanical Properties of Natural Fibre Reinforced Polymer Composites: A Review

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Abstract

Natural fibers are applicable as reinforcement in polymer used as composite in field of research. For which biodegradability specific strength and resistance to corrosion are some noticeable characters that enable natural fibers to be compared with few of the fibers developed synthetically. The study presents a literature review related to mechanical characterization and fabrication of a composite (hybrid) of natural fiber. Hybridically developed composites possesses high strength (flexural) and modulus of rigidity meanwhile flax or PLA only show high value for tensile strength.. In case of impact strength the hybrid composite has attain larger value. So, study emphasizes on the researches being conducted by researchers in the various field of reinforced composites tribology.

Key words: Natural fibers, tribology, polymers, reinforcement

Introduction

The deteriorating affect as a matter of worry for Steel Fiber Reinforced Polymer Composite (SFRPC) is concerning to the nature and moreover depletion of available resources related to petroleum has been gaining the concern from the scientists developing material and engineer towards Natural Fiber Reinforced Composite (NFRC). SFRPC is not comfortably degradable in natural manner after the desired life cycles has been achieved despite it is been composed to degrade, inspite that it kept emitting poisonous gases which lay impact on the environmental activities. Polymers and fibers developed synthetically are furiously used in many industries such as aerospace, sports and automobiles etc. Strict environmental rules and global energy shortage have arisen the hope for natural fibers used as polymeric composites. NFPC generally consists natural fiber as reinforcement and resin as matrix.

Despite the reinforced BNP/epoxy Nano composites as resulting fiber appear usable for various applications pertaining to engineering field, the calculation of its mechanical properties at various testing conditions has turned really challenging. It is generally due to the stress vs. strain behavior which turnout to be nonlinear resulting not because of externally applied parameters (as an example rate of strain vs temperature), although along with this from micro-structural properties (as like the weight fractions for fiber and also for nanoparticle).For betterment constitutive models physically based can play a major role in developing the models for material by evaluating the relations within stresses developed and deformations occur at the micro-scale level, inductions of new physical induction in the mechanisms at molecular scale and eliminating assumptions not required.

Hybridization been used for enhancing the composite's properties. For the experimental purposes jute fiber came into uses. The induction of NFRC has been gained remarkable development in technology pertaining to composite as a substitute to glass fibers. While composing the composites based on natural fiber, it is often create in convenience because the nature of the fibers being hydrophilic. It gives direction for making the composites in adjustable to hydrophobic polymer matrixes. Hence, Plants such as pineapple, ramie, bamboo, banana flax, hemp, cotton, jute, kenaf and sisal has been avail as a primary source for lignocelluloses. Such fibres are often applicable for the reinforcement in composites. Work on identification of the effects of process parameters over tensile strength related to fibre reinforced with jute thermoplastic used as composites has been done.

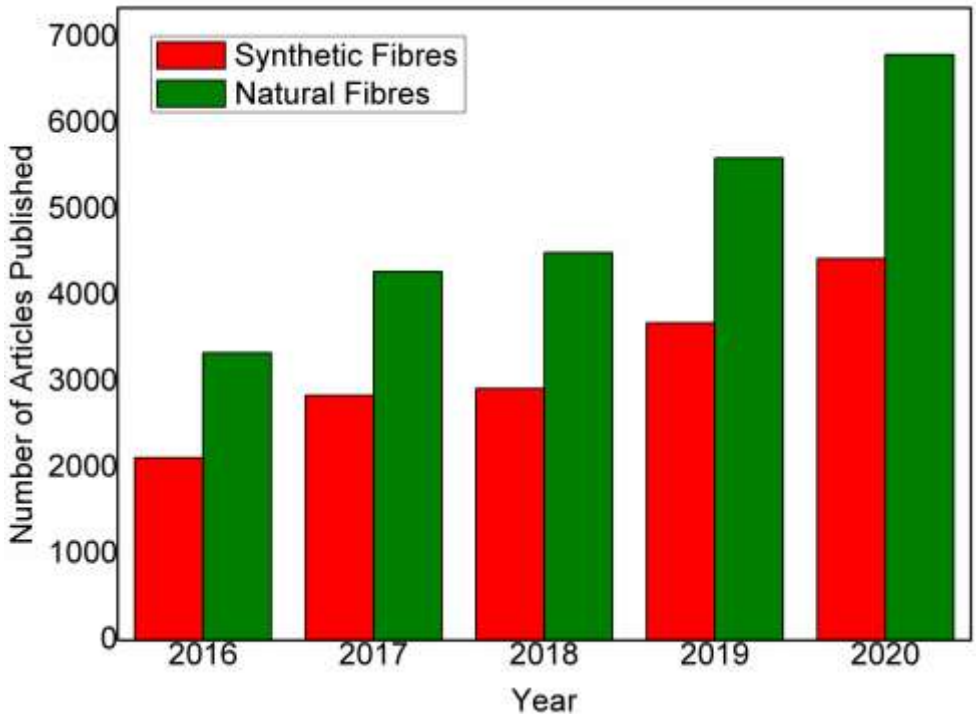

Figure 1. Number of articles published in last 5 years on mechanical characterization of synthetic as well as natural fibers based composites (Data is obtained from www.sciencedirect.com using keywords- Synthetic Fibers, Natural Fibers, Mechanical, Polymer Composites)

The usage of materials as a composite has becoming the better alternative in comparison to the conventional metals being used as aircraft machine parts majorly, reason being their durability, increment in quality, tolerance and resistance from corrosion and fatigue, for any damages. Now a days advanced structures is massively equipped with composites materials. Also environmental issues and sustainability are arising remarkably in the time frame in order to lessen pollution, safe and greener earth. Fiberglass has been used most widely composite material consisting the glass fibers inducted in resin as matrix. Its weight properties and bulk strength are in comparison with metals and is being conveniently shaped using molding processes. Earlier in the aircraft / Boeing 707 passenger jet in the 1950s fiberglass was used. Figure 1 shows the number of articles published in the last five years on mechanical characterization of synthetic as well as natural fibers reinforced polymer composites. A comparison is shown for both types of fibers. It can be seen from the Figure 1 that articles on natural fibers based composites are increasing year by year.

Literature survey

E.Munoz et al. (2015) analyzed the towards water absorption and variation on the flax fibre reinforced bio epoxy composites for mechanical properties focusing on sustainable green composites and eco- friendly preparation using RTM(resin transfer moulding) process .Diffusion coefficient ,water uptake values ,flexural properties are evaluated showing diffusion coefficient in the order of 10^{-6} mm^2/sec whereas water absorption have positive value with increment in tensile strength while increase in water content results decrease in flexural properties.

D.Gomes et al.(2018) studied absorption capability for water in fibre (sisal) reinforce polymer matrix composites at temperature of 25,50 and 70 degree Celsius with 44.6 percent sisal fibres and 55.4% polyester matrix in proportion manufactured using hand layup technique water absorption were evaluated .Results showed favourable water absorption relationship, moisture content gradients are larger in the surface planes while diffusion coefficient dependent on the moisture content, geometrical shape and temperature.

K.Senthil kumar et al. (2019) reviewed mechanical behaviour evaluation of sisal fiber reinforced polymer composites also various factors such as fiber loadings ,fiber length ,fiber architecture ,chemical treatment hybridization .As a result hybridization ,filler or additives improve the mechanical properties .Impact strength decreases, also chemical treatment involve negligible health risk ,but can easily raise the mechanical properties and lowers the absorption capability for water of the sisal fibres.

Sowmya et al.(2017) investigated composite material (hybrid) using hemp fibres and jute fibres and through FEM its mechanical properties. The fabricated material with the help of hand layup technique were subjected to water test, specific gravity ,flexural ,impact , tensile and hardness tests .As a result hybrid composite has flexural strength of 120.6 MPa ,tensile strength of 79.13 MPa and higher specific gravity at 90 degree orientation.

Ankit Manrat et al. (2019) studied static and dynamic mechanical properties of PLA bio-composites with hybrid reinforcement of

flax, jute and hemp as reinforcement and epoxy as matrix material. Hybridization of fiber done by intermixing the fibres, layer by layer. Hybrid composite achieved higher flexural strength and modulus , whereas non-hybrid flax/PLA have higher strength ,higher glass transition temperature, storage modulus value and less modulus value in comparison to developed hybrid composites.

Asokan Pappu et al. (2019) examined the manufacturing and characterization of sustainable hybrid composites using sisal and hemp fibre as reinforcement of poly lactic acid via injection moulding and extrusion and their performance was evaluated. The hybrid.83d composite resulted in good material properties in terms of tensile strength (46.1 MPa),young's modulus(94.83 MPa), and low water absorption (1.06).

Thiagamani et al. (2019) investigated the mechanical properties; absorption capability and behaviour towards swelling of hemp/sisal fibre reinforced bio epoxy hybrid composite fabricated by hand layup technique after that by hot press with different stacking sequences. Behaviours such as tensile strength, compressibility, inter-laminar properties, shear strength and hardness response, density improvement, void connectivity, absorption capability towards water and thickness for swelling also even analyzed. As a result tensile strength enhances to 25.66 MPa, compressive strength 22.4 MPa.

Effect of water absorption on mechanical properties of polyester composites has been studies by Haameem et al. (2016). 53.3 % and 60.75% reduction on tensile strength, and flexible strength has been observed as compare to dry polyester composites by Haameem et al. (2016).

Effect of water absorption on mechanical properties of hemp polyester composites has been studies by Dhakal et al. (2016). 3-4 layers of hemp fibres have been observed during immersion test which of hemp polyester composites which is conducted by Dhakal et al. (2016). Due to the presence of 3-4 layers of hemp fibres, high amount of cellulose has been identified in the wetted hemp fiber as compared to dry hemp fibres and lastly the presence of high amount of fibres decreases the flexible strength of hemp fibres during immersion test.

Effect of water absorption on mechanical properties of jute, hemp and flax based epoxy polymer has been studies by Chaudhary et al. (2016). 46.9 % and 45.1% reduction on tensile strength, and flexible strength has been observed as compare to dry jute, hemp and flax based epoxy polymer by Chaudhary et al. (2016). Although, no significant reduction in hardness has been observed by Choudhary et al. (2016) during the immersion test.

46.9%, and 45.1% red

Behrouz Arash et al. (2019) examined viscoelastic response of fiber reinforced nano particle equipped epoxy nano-composites studying stress vs. strain relationship for the nano-composites along with the non-linear hypo elastic time varying and softening behaviour by modulus enhancement model .Results shows stress vs. strain relationship are in good agreement, which provide a suitable measures for examining fiber reinforced nano-particle/ epoxy nano composites.

R.C.T.S Felipe et al. (2019) researched into effect accelerated environment deterioration (sequential cycles of moisture , hot stream and UV radiation) into polymer composite laminate using different hybridization methods : Glass/Kelvar and glass strands .After getting exposure ,the specimens undergoes structural integrity assessment, followed by uniaxial tensile strength and bending tests and characteristics towards fracture evaluation. The lamination with hybrid strands results the highest losses, generally in strain and 84 percentages in tensile strain and between layers delamination is done.

Santosh Todkar et al.(2019) evaluated mechanical properties of PALF polymer composites .Fabrication method is solution mixing technique ,compression molding and injection molding .Multistep manufacturing contribute to increment in the cost of highly reliable natural fibers as well as the enhanced behaviour of the composites. Two sequential chemical treatments are conducted out then it has a grip over the chemical and higher mechanical properties .Hybridization with various other naturally or synthetically developed fibers has found impactful.

Conclusion

The global environmental concerns and government regulations have paved the way for increased use of natural fibres based composites in various applications. It also led to different scholars and researchers to work out new materials for better mechanical properties of these composites. On the basis of above discussion it can be concluded that water absorption has a significant impact on mechanical properties of these composites. It can be minimized by various methods like chemical treatment of natural fibres before composite fabrication.

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