A review on bagasse fiber reinforced composites with polyester and epoxy Resin matrices

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Abstract: **Bio composite is a material produced by a matrix and a reinforcement of natural fibers like Jute, Coir, Sisal, Pineapple, Ramie, wicker, Banana and Bagasse, etc. Such natural fibers composites are low-cost fibers with high specific property, low density and green. The development of sophisticated bio composite materials made is increasing worldwide. It will be an another way to build up the bio composites which can be particularly used for daily needs of common people whether it is house embrace furniture, house, fencing, deck, floor covering, and light weight car parts or sports equipments. This effort to develop a bio composite material with improved performance for global applications is a continuous ongoing process. Thousands of tons bagasse is created but most of their wastes do not have any useful utilization. This bagasse waste can be used to set up fiber reinforced polymer composites for commercial use. This work discusses the development of bagasse fiber reinforced polymer composite, types of matrix, processing methods, and any alteration of the fiber and its applications.**

Keywords: **Bio composites, Polymer Matrix, Natural fibers, Bagasse fibers, Epoxy resin, polyester.**

1. Objectives

The main purpose of this review with Bagasse fibers is to develop a natural fiber composite by high mechanical behaviors and to present it as a modified natural and renewable option to reinforced with both thermoplastic and thermo set matrix, which satisfy the needs (properties, availability and cost. The aim is to produce an alternative for other natural and particularly synthetic fibers such as glass fiber, used nowadays for this purpose.

2. Introduction

Over the recent years, a several researches have been involved in investigating the exploitation of natural fibers as load carrying substances in composite material. The utilization of such materials in composite has increased due to their low cost, their ability reuse and for the fact that they can compete well in terms of strength of material. Natural fibers can be described as composites which are naturally occurring consisting mainly of cellulose fibrils fixed in lignin matrix. Along the length of the fiber the cellulose fibrils are aligned, which render higher tensile and flexural strength.[1] The reinforcing efficiency of natural fiber is corresponding to the cellulose with its crystalline. The usage of polymer based composite material is increasing because of their light weight, good mechanical and tri biological responses. However, composites encounter problems such as fiber crack. Fiber crack and matrix cracking plays an important role in laminates under tensile load [2-4].

2.1. Polymer Matrix Composites

Polymer Matrix Composite (PMC) is the material that consisting of a polymer (resin) matrix mixed with a fibrous reinforcing dispersion. PMC are very popular due to their low cost and simple fabrication methods. Use of non – reinforced polymers as bonded materials is limited by low level of their mechanical properties: tensile strength of one of the strongest polymers – epoxy resin is 140MPa (20000 psi). In addition to comparatively low strength, polymer materials are possessing minimum impact resistance.[3] PMC are characterized by High tensile strength, High fracture toughen, High stiffness, better moisture resistance, better abrasion resistance, Good corrosion resistance & Low cost. The major disadvantages obtained by PMC are low thermal resistance and high coefficient of thermal expansion.

2.2. Reinforcement

The major reason of the reinforcement in a composite material is to increase the mechanical properties of the neat resin system. The fibers takes part in composites have variant properties and so it affects the properties of the composite material in variant methods. For most of the applications, the fibers need to be arranged into some form of sheet, known as a fabric, to make handling possible.

Reinforcing fibers may be arranged in different forms, Unidirectional fibers, Roving's ,Veil mat thin pile of randomly dispersed and looped continuous fibers, Chopped strands thin pile of randomly orientated and looped short (3-4 inches) fibers Woven fabric.

2.3. Fiber source

Fibers are a class of hair-like structured material that are continuous filaments or are in separately elongated pieces, like pieces of thread. They can be blend into filaments, thread, or rope. They are used as a component of composites materials. They can also be bonded into sheets to make products such as paper or felt[2]. The plants which produce natural fibers are grouped as primary and secondary depending on their utilization. Primary plants are those which have been grown for their fiber particles while secondary plants are plants in which the fibers are extracted as a by-product.[5] The primary plant fibers are Jute, hemp and sisals. Pineapple, Bagasse, oil palm and coir are examples of secondary plant fibers.

2.4. Bagasse

One of the widely used agricultural sources of biomass energy in the world is Sugarcane. Two types of biomass can be produced by Sugarcane namely Cane Trash and Bagasse. Bagasse is the fibrous residue left over after milling of the Cane, with having 45-50% moisture content and consisting of a mixture of hard soft fiber and smooth parenchymatous (pith) tissue with maximum hygroscopic property [6]. Bagasse contains mainly following substances namely cellulose, hemi cellulose, pent sans, lignin, Sugars, wax, and minerals. The obtained quantity varies from 22 to 36% on Cane and it is due to the fiber partition in Cane and the cleanliness of Cane that has been supplied, which, in turn depends on harvesting practices. The composition of Bagasse depends on the types and properties of Sugarcane as well as applied harvesting methods and efficiency of the processing method of sugar. Bagasse is usually burned in furnaces for power generation by producing steam. Bagasse is also emerging material for bio ethanol production. It is also u as the used as a raw material for paper production and cattle feedstock. The value of Bagasse fuel is based on its calorific value, which in turn is affected by its composition, especially with respect to its moisture content and to the Sugarcane crops calorific value of the, which depends mainly on its sucrose content.[4] A Sugar factory produces nearly 30 tons of wet Bagasse From every 100 tons of Sugarcane crushed. Bagasse is often used as a basic fuel source for Sugar mills; when it burned in quantity and produces sufficient heat and electrical energy to supply all the needs of a typical Sugar mill, with energy to spare. The CO_2 emissions resulting from the sugar mills are equal to the amount of CO_2 that can be absorbed by the plant during its growing phase, which makes the suitable process of cogeneration greenhouse gas-neutral. There exist an excellent opportunity in fabricating bagasse based composites towards a wide array of applications in construction such boards and blocks as reconstituted wood, flooring tiles .It would also ensure international market for cheaper and better substitution. Natural fibers have the advantages of low density, relative cheapness and biodegradable.

Fig. 1 Bagasse Fiber from sugar cane

2.5. Epoxy Resin

Epoxy resins are low molecular weight pre-polymers having at least two epoxies groups. The epoxies group is also sometimes referred to as a glycidyl or oxidant group.

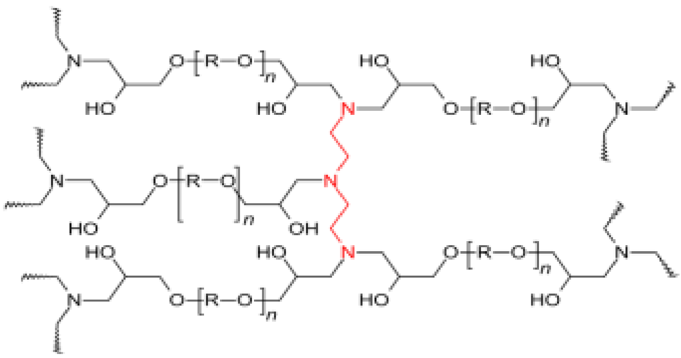
Epoxy resins are polymeric or semi-polymeric materials, and rarely exist as pure substances and since variable chain length results from the polymerization reaction that produces them. High purity substance can be produced for some applications, e.g. using a distillation purification process. One important of high purity liquid grades is their ability to form crystalline solids due to their highly common structure, which require melting operation to enable processing.

An important criterion for epoxy resins is the epoxies content. This is commonly expressed as the epoxies number, which is the number of epoxies equivalents in 1 kg of resin (Eq./kg), or as the resins equivalent weight, which is equal to the weight in grams of resin containing 1 mole alike of epoxies (g/mol). One measure may be converted to another one by:

Equivalent weight (g/mol) = 1000 / epoxies number (Eq./kg)

The equivalent weight or epoxies number is used to determine the amount of co-reactant (hardener) to apply when curing epoxy resins. Epoxies are typically cured with stoichiometric to achieve maximum physical properties.

As with other classes of thermo set polymer materials, blending with different grades of epoxy resin, as well as use of additives, some plasticizers or fillers is commonly to achieve the preferred processing and/or final properties, or to decrease cost. Use of blending, additives and fillers is often referred to as formulating.



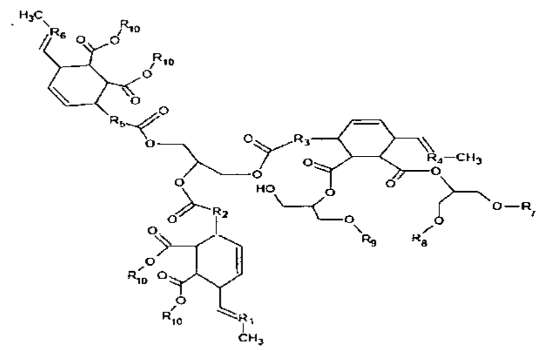
Chemical Structure of Epoxy Resin

Structure of a cured glue of epoxy. The hardener triamine is shown in red, the resin in black. The resin's epoxies groups have completely reacted with the hardener and are not present anymore. The material is highly cross linked and contains many OH groups, which confer adhesive properties

The applications for epoxy-based material are wide and include coating, adhesives and composite materials such as those using carbon based fiber and fiberglass reinforcements.[7] The chemistry of epoxies and the commercially available range of variation allow cure polymers to be formed with a very wide range of properties. In general, epoxies are well known for their excellent adhesiveness, chemical and heat resistance, good-to-excellent mechanical behavior and very good electrical insulating property. Many properties of epoxies can be modified (for example silver-filled epoxies having good electrical conductivity are available, while epoxies are usually electrically insulated). Variations producing high thermal insulation, or thermal conductivity combine with high electrical resistance for electronics applications, are available.

2.5. Polyester resin

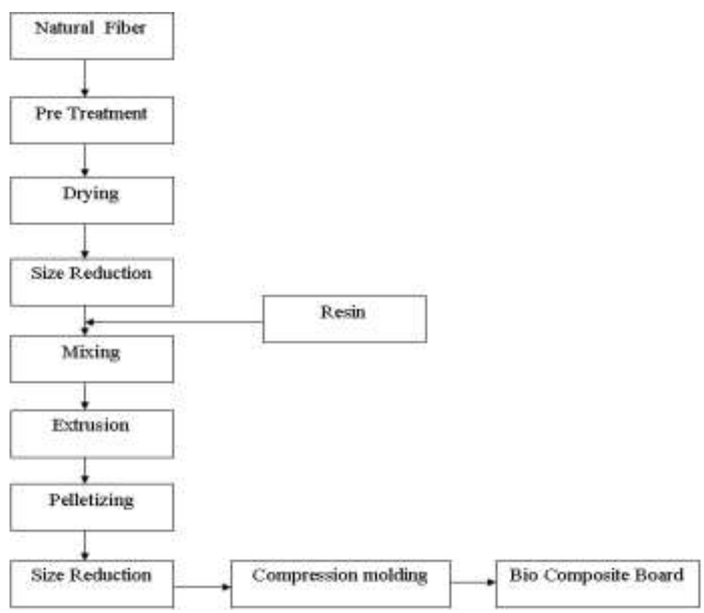
Polyester resins are one unsaturated synthetic resins formed by the reaction of dibasic organic acids and polyhydric alcohols. A commonly used raw material is Malefic Anhydride with di acid functionality. These resins are used as compounds in sheet molding compound with compound and the toner of laser printers. Wall panels which are fabricated from polyester resins reinforced with fiberglass called fiberglass reinforced plastic (FRP) — are commonly used in restaurants, kitchen stores, restrooms and other areas that require low-maintenance walls. Unsaturated polyesters are the condensation polymers produced by the reaction of polios (also known as polyhydric alcohols), organic compounds with multiple alcohol or hydroxyl functional group by saturated or unsaturated dibasic acids. Typical polyesters are used as glycols such as ethylene glycol acids used are ophthalmic and malefic.[8] Water is continuously removed, and driving the reaction to completion. The use of unsaturated polyesters and additives such as styrene reduces the viscosity of the resin.



Chemical Structure of Polyester Resin

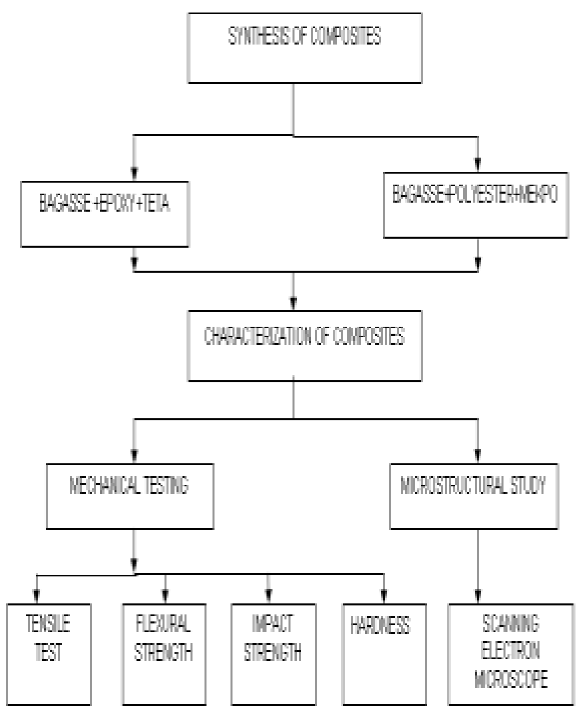
The initially liquid resin converts ass a solid by cross-linking chains.[9] This can be done by creating free radicals at unsaturated bonds, that propagates in a chain reactions with other unsaturated bonds in adjacent molecules, connecting them in the process. The first free radicals are induced by addition of compound that simply decomposes into free radical. This composite is usually and incorrectly known as the catalyst. The Substances are usually organic peroxides such as benzyl peroxide or methyl ethyl ketone peroxide.

2.6. Preparation of Bio composite



3. Experimental Procedure

The Bagasse fibers were chemically treated with NaOH solution. The Bagasse fiber was immersed in NaOH solution for 24 hours and then take it out and dried it in a sunlight. Figure 2 shows that the synthesis of Bagasse -epoxy and Bagasse -polyester composite with relevant weight in grams. The fibre resin weight percentage is taken as 18:82 .The hardener used for epoxy resin is triethylene tetramine (TETA) and for the polyester is methyl ethyl ketone peroxide (MEKPO). The required fibers were added to the resin mixed hardener with required weight percentages. The fiber resin hardener mixture was poured into moulds for taking different testing prepared as per ASTM standards. The setting for the composites was approximately for 24 hours. Then the prepared composites were subjected to,tensile, hardness, flexural and impact tests. Hardness was measured using Rockwell hardness tester as per ASTM D785 standard. The synthesis of composites includes two composites of Bagasse with polyester and epoxy resins, and the characterization includes the testing of the composites.



Synthesis of Bagasse fiber reinforced composites

3.1. Tensile Test

The tensile test the specimen is prepared according to the ASTM D3039 standards. Figure shows Universal Testing Machine on which the tensile and three point bending tests were carried out on the composites the tensile test was measured from the universal testing machine.[10] The specimen was held on the machine and tensile force was applied. The force Vs displacement graphs are plotted according to the noted displacement. Tensile tests were conducted in a Universal Testing Machine. The specimen dimensions were (ISO 14125): 60 mm × 15 mm × 2 mm.

3.2. Flexural Test

Static flexural tests were carried out in the flexural testing machine according to ASTM D 790-00 [20].

3.3. Charpy Impact Test

Dynamic charpy impact tests were conducted on composite specimens of un-notched mode according to ASTM D 6110-97 using a Impact testing machine.
(MT-3016, Pendulum type, Germany). The sudden load is applied to the Specimen in this testing.

3.4. Hardness Test

The hardness of the composites was measured using a HPE Shore-A Hardness Tester (model 60578, Germany) according to ASTM D785-98 synthesis of composites
The two types of hardness test can bs taken they are brinell and Rockwell hardness

4. Conclusion

The present review of composite material has been undertaken, with an objective to explore the potential of the bagasse fiber polymer composites and to study the mechanical properties of bagasse composites. The present review reports the use of bagasse fibers, as polymer matrix reinforcements. This review focused at providing knowledge to enhance further research in this area. Natural fabric composites are generally less strength performance compared to composites of hybrid materials. However, they have the advantages of flexibility in design, low cost, lack of health-hazard problems and recycling possibilities. Hybrid formation of some amounts of synthetic fibers makes these natural fabric composites more suitable for technical applications as in automotive interior parts. The possibility of surface chemical modification of bagasse fibers have been extensively used in several of application, e.g., packaging, furniture and electronic display materials.

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