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INVESTIGATION OF MECHANICAL PROPERTIES OF CORN FIBER REINFORCED WITH BIODEGRADABLE RESIN

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Recently environmental awareness, ecological concerns and new legislations, bio-fiber-reinforced composites have received increasing attention. The composites have many advantages over traditional glass fiber or inorganic mineral-filled materials, including lower cost, lighter weight, environmental friendliness, and recyclability. Corn fiber has similar characteristics to polyester staple fiber and has the luster of silk, meanwhile its moisture regain surpass polyester, so the fabric made of it is much comfortable.Natural fibre reinforced composites are being worked upon for various engineering applications. Various natural fibres such as jute, sisal, palm, coir and corn are used as reinforcements. Corn-based biodegradable polymers that can be turned into plastics, fabrics and fibers .The poor adhesion between fibre and matrix is commonly encountered problem in natural-fibre-reinforced composites. To overcome this problem, specific physical and chemical treatments were suggested for surface modification of fibres by investigators In this paper sufficient number of corn fiber biodegradable resin composite specimen are fabricated as per the ASTM standards and various mechanical properties such Tensile strength and Impact test are studied.

1. INTRODUCTION

1.1 OVERVIEW OF COMPOSITES

A "composite" is when two or more different materials are combined together to create a superior and unique material.This is an extremely broad definition that holds true for all composites,however,more recently the term "composite" describes reinforced plastics.

A composite is combination of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load carrying members.

Composites are hybrid materials made of a polymer resin reinforced by fibres, combining the high mechanical and physical performance of the fibres and the appearance, bonding and physical properties of polymers, the short and discontinuous fibre composites are responsible for the biggest share of successful applications, whether measured by number of parts or quantity of material used.

composites combine a high stiffness and strength with a low weight and their admirable feature of corrosion resistance in polymeric composites. These composites have economic benefits by using inexpensive raw materials and zero

maintenance during service. Composites are now a part of everyday life, and have entered nearly all major industrial, commercial and domestic sectors, including aerospace, packaging, sports industry, hose hold appliances etc. Attention towards biodegradable polymers is increasing day by day due to severe concerns on managing carbon emissions in a sustainable manner, and the environmental requirements on safe and effective disposal of plastic polymers after use. Poly lactic acid (PLA), produced from annually renewable biofeedstock like corn, is one of the most important biodegradable polymers and is used in lot of commercial applications.

- High strength to weight ratio (low density high tensile strength)
- High creep resistance
- High tensile strength at elevated temperatures
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1.2 CLASSIFICATION OF COMPOSITES

Composite materials can be classified into three groups on the basis of matrix material. They are:

Classification of Composites 1
(based on matrix material)
a) Metal Matrix Composites (MMC)
b) Ceramic Matrix Composites (CMC)
c) Polymer Matrix Composites (PMC)

a) Metal Matrix Composites

Metal Matrix Composites have many advantages over monolithic metals like higher specific modulus, higher specific strength, better properties at elevated temperatures, and lower coefficient of thermal expansion. Because of these attributes metal matrix composites are under consideration for wide range of applications viz. combustion chamber nozzle (in rocket, space shuttle), housings, tubing, cables, heat exchangers, structural members etc.

b) Ceramic matrix Composites

One of the main objectives in producing ceramic matrix composites is to increase the toughness. Naturally it is hoped and indeed often found that there is a concomitant improvement in strength and stiffness of ceramic matrix composites.

c) Polymer Matrix Composites

Most commonly used matrix materials are polymeric. The reason for this are two fold. In general the mechanical properties of polymers are inadequate for many structural purposes. In particular their strength and stiffness are low compared to metals and ceramics. These difficulties are overcome by reinforcing other materials with polymers. Secondly the processing of polymer matrix composites need not involve high pressure and doesn't require high temperature. Also equipments required for manufacturing polymer matrix composites are simpler. For this reason polymer matrix composites developed rapidly and soon became popular for structural applications. Composites are used because overall properties of the composites are superior to those of the individual components.

Classification of Composites 2
(based on reinforcing material structure)

1. **Particulate Composites**

Particulate Composites consist of a matrix reinforced by a dispersed phase in form of particles

Laminate Composites

When a fiber reinforced composite consists of several layers with different fiber orientations,it is called **multilayer composite.**

Structure factors affecting properties of composites are as follows:

- Bonding strength on the interface between the dispersed phase and matrix;
- Shape of the dispersed phase inclusions (particles, flakes, fibers, laminates);

1.3 LITERATURE REVIEW

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fiber-reinforced composites, owing to their superior properties, are usually applied in different fields like defense, aerospace, engineering applications, sports goods, etc. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties. A lot of work has been done by researchers based on these natural fibers. Natural fibers such as jute, sisal,corn, silk and coir are inexpensive, abundant and renewable, lightweight, with low density, high toughness, and biodegradable. Natural fibres such as jute have the potential to be used as a replacement for traditional reinforcement materials in composites for applications which requires high strength to weight ratio and further weight reduction. Bagasse fiber has lowest density so able to reduce the weight of the composite upto very less. So by using these fibers (jute,corn, bagasse, and lantana camara) the composite developed is cost effective and perfect utilization of waste product.

Natural fiber reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibers in fiber reinforced composites. They are high specific strength and modulus materials, low prices, recyclable, easy available in some countries, etc.

1.4 MATERIALS AND METHODS

The following section will elaborate in detail the experimental procedure carried out during the course of our project work. The steps involved are:

1. Specimen Fabrication (Fabrication of FRP).
- By Hand Lay-Up method.
- Compression Molding
- Injection Molding
- Transfer Molding
2. Compression test
3. Tensile test
4. Charpy impact test

1. **Special Fabrication**

Open mold fabrication of polymer matrix composites:

- Open Molding (Contact Molding) is the simplest method of fabrication of Polymer Matrix Composites.
- Open Molding is usually used for manufacturing large individual parts (swimming pools, boat bodies).
- Open Molding method is mostly used for fabrication Glass fiber

Hand Lay-up

The most popular type of Open Molding is Hand Lay-up process. The Hand Lay-up is a manual, slow, labor consuming method, which involves the following operations:

- The mold is coated by a release anti-adhesive agent, preventing sticking the molded part to the mold surface.
- The prime surface layer of the part is formed by applying gel coating.
- A layer of fine fiber reinforcing tissue is applied.
- Layers of the liquid matrix resin and reinforcing fibers in form of woven fabric, rovings or chopped strands are

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applied. The resin mixture may be applied by either brush or roll.

- The part is cured (usually at room temperature).
- The part is removed from the mold surface.

The disadvantages of the Hand Lay-up method are: low concentration of reinforcing phase (up to 30%) and low densification of thecomposites (entrapped air bubbles).

1.5 COMPRESSION MOLDING

Compression Molding is a process in which a molding polymer is squeezed into a preheated mold taking a shape of the mold cavity and performing curing due to heat and pressure applied to the material.The method is used mostly for molding thermosetting resins (thermosets), but some thermoplastic parts may also be produced by Compression Molding.
The method uses a split mold mounted in a hydraulic press.

Alkali Treatment

Corn fibers were cleaned and dipped in 5% NaOH solution for 30 minutes at room temperature. After this, the corn fibers were filtered and thoroughly washed with distilled water and subsequently neutralized with 2% HCl solution.During the entire neutralizing time litmus paper test was carried out at proper intervals to check the neutrality. Finally the NaOH treated fibers were dried in an oven at 80oC for 3 hours.

Permanganate Treatment

Corn fibers were initially dipped in 5% NaOH solution for 30 minutes at room temperature. Then they were filtered and washed properly with distilled water to remove sodium hydroxide. Following this, these fibers were soaked in 1% Potassium permanganate in acetone solution for 20 minutes. Finally they were filtered and dried at 80oC for 3 hours.

Polyester Resin

Polyester resins are unsaturated resins formed by the reaction of dibasic organic acids and polyhydric alcohols. Polyester resins are used in sheet moulding compound, bulk moulding compound and the toner of laser printers.Wall panels fabricated from polyester resins reinforced with fiberglass so called fiberglass reinforced plastic (FRP) are typically used in restaurants, kitchens, restrooms and other areas that require washable low-maintenance walls.

Unsaturated polyesters are condensation polymers formed by the reaction of polyols (also known as polyhydric alcohols), organic compounds with multiple alcohol or hydroxy functional groups, with saturated or unsaturated dibasic acids. Typical polyols used are glycols such as ethylene glycol; acids used are phthalic acid and maleic acid. Water, a by-product of esterification reactions, is continuously removed, driving the reaction to completion. The use of unsaturated polyesters and additives such as styrene lowers the viscosity of the resin. The initially liquid resin is converted to a solid by cross-linking chains. This is done by creating free radicals at unsaturated bonds, which propagate in a chain reaction to other unsaturated bonds in adjacent molecules, linking them in the process. The initial free radicals are induced by adding a compound that easily decomposes into free radicals. This compound is usually and incorrectly known as the catalyst[. Substances used are generally organic peroxides such as benzoyl peroxide or methyl ethyl ketone peroxide.

Polyester resins are thermosetting and as with other resins,cure exothermically.the use of excessive catalyst can cause charring or even ignition during the curing process.

COBALT(II)NAPHTHENATE

Cobalt(II) naphthenate is a mixture of cobalt(II) derivatives of naphthenic acids. Cobalt Naphthenate is a cobalt source that is soluble in organic solvents as an organometallic compound (also known as metalorganic, organo-inorganic and metallo-organic compounds). Cobalt naphthenate is the cobalt salt of naphthenic acids. Cobalt naphthenate is thus a member of the metal carboxylates group. All of the metal carboxylate salts are designed to add metals to chemical reactions. They therefore are expected to dissociate into free metal and free acid.

FLEXTURAL TEST(D 7264)

The parameters for this test are the support span,the speed of the loading and the maximum deflection for the test.these parameters are based on the test specimen thickness and are defined differently by ASTM and ISO.

CHARPY IMPACT TEST(A 370)

The charpy impact test is also known as the charpy v-notch test,is a standardized hih strain-rate which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of agiven material's toughness and acts as a tool to study temperature –dependent ductile brittle transition.

TENSILE TEST

Tensile testing is used to measure the force required to break a polymer composite specimen and the extent to which the specimen stretches or elongates to that breaking point. Ultimate tensile strength(UTS),often shortened to tensile strength(TS) or ultimate strength, is the maximum stress that a material can withstand while being stretched or pulled before necking, which is when the specimen's cross-section starts to significantly Contract. Specimens are placed in the grips of a universal test machine at a specified grip separation and pulled until failure.

CONCLUSION

It is never ending search for formulating products ,both automotive and non automotive,with the perfect balance of Low cost,high strength,low weight and environmentally friendliness.in–line compounding has shown continued promise of findingthis optimum set of materials through the use of unique.

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