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International Journal OF Engineering Sciences &Management Research

REVIEW ON FABRICATION PROCESS OF NATURAL FIBRE REINFORCED COMPOSITES

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ABSTRACT

Materials are probably more deep rooted in our world than most of us realize, i.e. in transportation, housing, clothing, communication, food production, etc., virtually every segment of our daily lives are influenced by materials. The development and advancement of societies have been tied with the ability to produce and manipulate materials to fulfil their needs. The discipline of material science involves investigating the relationship that exists between the structure and properties of material. The structure of materials usually relates to the arrangement of its internal components. Solid materials have been classified into three basic classifications, viz., metals, ceramic and polymers. This classification is primarily based on chemical makeup and atomic structure, most material fall into these categories. In this regard a brief survey on natural fibres are studied and concluded.

Keywords: *Composites, natural fibers, classification, fabrication process*

INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials because of their low density, good mechanical performance, unlimited availability and problem free disposal. Natural fibres offer a real alternative to the technical reinforcing fibres presently available. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated industrial applications. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of the transportation industry. Natural fibres can compete with glass fibres especially with respect to the specific stern birth and specific stiffness Composites were a need in the evolution of engineering materials because by a combination of materials it is possible to overcome, for instance, brittleness and poor process ability of stiff and hard polymers. The developments in composite material after meeting the challenges of aerospace sector have cascaded down for catering to domestic and industrial applications. Composites, the wonder material with light weight, high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, wood etc. Now-a-days, the use of natural fibre reinforced composites starts gaining popularity in engineering applications due to the fact that this material possesses characteristics that are comparable to conventional materials. The shift of composite applications from aircraft to other commercial uses has become prominent in recent years.

HISTORY

Fiber reinforced polymer matrix composite materials are being introduced in ever increasing quantities in military systems and have become a key element in the Department of Defence's effort to lighten the force. Composites have been used throughout history, i.e., straw in bricks, metal rod-reinforced concrete, and lightweight aerospace structures. The high temperature alternative to high density metals is ceramics, offering weight savings as well high temperature capability and oxidation resistance. However, polymer matrix composites have an inherent temperature limitation based on their hydrocarbon structure. The development of ceramic composites and associated flaw-tolerant microstructures has been a major goal of structural ceramics over the past two decades.

Advantages of composites over their conventional counterparts are the ability to meet diverse design requirements with significant weight savings as well as strength-to-weight ratio. Some advantages of composite materials over conventional ones are as follows:

ISSN 2349-6193
Impact Factor: 2.805

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- Tensile strength of composites is four to six times greater than that of steel or aluminium (depending on the reinforcements).
- Improved torsional stiffness and impact properties.
- Higher fatigue endurance limit (up to 60% of ultimate tensile strength).
- 30% - 40% lighter for example any particular aluminium structures designed to the same functional requirements.
- Lower embedded energy compared to other structural metallic materials like steel, aluminium etc.
- Composites are less noisy while in operation and provide lower vibration transmission than metals.

Most commonly used matrix materials arepolymeric. 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 for example polymer/ceramic. Composites have a greater modulus than the polymer component but aren't as brittle as ceramics. Two types of polymer composites are:

- Fiber reinforced polymer (FRP)
- Particle reinforced polymer (PRP)

The interest in natural fiber-reinforced polymer composite materials is rapidly growing because they are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, used from time immemorial as a source of lignocelluloses fibers, are more and more often applied as the reinforcement of composites. Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites.

CLASSIFICATION OF NATURAL FIBERS

Fibers are of hair-like material that are continuous filaments or are in discrete elongated pieces, similar to pieces of thread. Fibers are of two types: natural fiber and manmade or synthetic fiber. Figure 1.1 shows the classification of natural fibers.

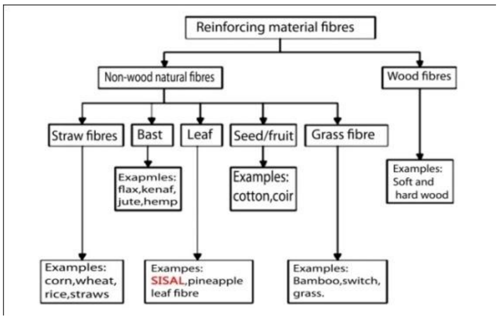

Fig.1.1 Classification of natural fibers

Animal fiber for the most part contain proteins; cases mohair, fleece, silk, alpaca, angora. Animal hair (fleece or hair) are the fibers taken from animals or bristly warm blooded animals. E.g. Sheep's fleece, goat hair (cashmere, mohair), alpaca hair, horse hair, and so on. Mineral fibers are naturally happening fiber or somewhat adjusted fiber acquired from minerals. These can be arranged into the accompanying classes: Asbestos is the main naturally occurring mineral fiber. Variations are serpentine and amphiboles, anthophyllite. Plant fibers are of cellulose oriented plant fibers, examples like sisal, kenaf, jute, coir, hemp, seeds, bast of plants, kopak, vegetable fibers etc. again these plant fibers are sub divided into bast, leaf ,seed, wood and grass stem fibers.

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Fabrication Process

Hand Lay – Up

The most popular type of open molding is hand lay – up process. It is simple but effective process which takes relatively low capital investment but higher labor cost.The hand lay- up operation takes place as follows; Pigmented gel coat is first applied by brush or spray. After gel coating, a thin coat of resin and a thin layer of reinforcement are placed on, and worked by hand with brushes and rollers, so the fully impregnates the fabric. Other layers follows, until the desired thickness and strength are achieved. After cure, the component is pulled out of the mold and trimmed. The mold is cleaned, released and returned to use. Quality is relatively poor, mainly because high resin/reinforcement ratio is incorporated in the finished product.

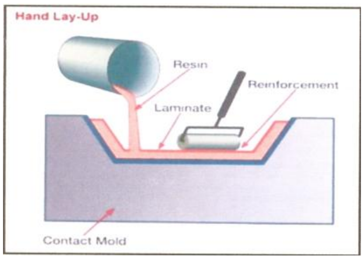

Fig.1.2 Hand Lay-Up Process

Spray – Up Method

Spray – up or chopping is an open mold method similar to hand lay – up. A chopped laminate has good conformability and is sometimes faster than hand lay – up in molding complex shapes. In the spray up process the operator controls thickness and consistency, therefore the process is more operator dependent than hand lay–up. Chopped fiber reinforcement together with resin in the form of a spray is deposited simultaneously on to the released and gel coated open mould surface. Quality is poor, mainly because the component incorporates a high resin ratio, but it is a very economic way of manufacturing low priced parts.

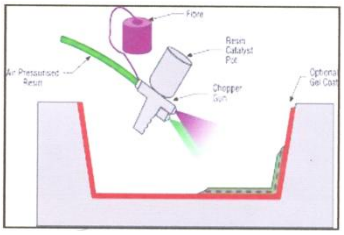

Fig.1.3 Spray up technique

Filament Winding

Filament winding is an automated open molding process that uses a rotating mandrel as a mold. Continuous strand is fed through a resin bath and wound onto a rotating mandrel. The male mold configuration produces a finished inner surface and a laminate surface on the outside diameter of the product. Filament winding results in a high degree of fiber loading which provide high tensile strength in the manufacturing of hollow, cylindrical products such as chemical ad fuel tanks, pipes, stacks, pressure vessels, and rockets motors cases.The process makes a high strength to weight ratio laminates and a high degree of control over uniformity and fiber orientation.

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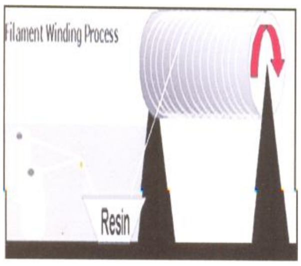

Fig.1.4 Filament winding process

Compression Molding

Compression molding is a high volume; high pressure method suitable for molding complex, fiber glass reinforced plastic parts on a rapid cycle time. The mold set is mounted on a hydraulic or mechanical molding press. The molds are heated to 2500 to 4000F. A weighed charge of molding compound is placed in the open mold. The two halves of the mold are closed and pressure is applied. Depending on thickness, size, and shape of the part, curing cycle range from less than a minute to about five minutes. The mold is opened and the finished part is removed.

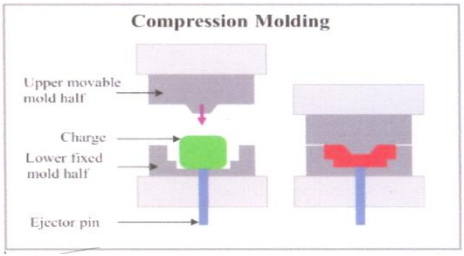

Fig.1.5 Compression molding

Pultrusion

Pultrusion is a continuous process for the manufacturing of products having a constant cross section. Continuous strand fiber, mat, cloth is impregnated in a resin bath, and then pulled through a steel die, by a powerful tractor mechanism. The steel die consolidates the saturated reinforcement, sets the shape of the stock, and controls the fiber/resin ratio. The die is heated to rapidly cure the resin.

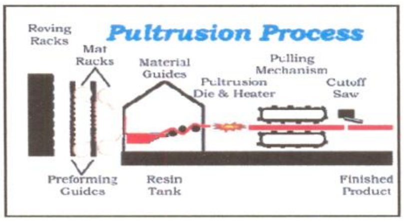

Fig.1.6 Pultrusion process

VACUUM BAG MOLDING

Vacuum bag molding improves the mechanical properties of open- mold laminates. By reducing the pressure inside the vacuum bag, external atmospheric pressure exerts force on the bag.In vacuum bagging places a release film over the lay-up on the mold and sealed, followed by a bleeder ply of fiberglass cloth, polyester cloth, or other material, that absorbs excess resin from a laminate. A breather ply of a non-woven fabric is placed over the bleeder ply, and the vacuum bag is mounted over the entire assembly. Pulling a vacuum from within the bag uses atmospheric pressure to eliminate voids and force excess resin from the laminate. It results in better adhesion between layers of construction.

ISSN 2349-6193
Impact Factor: 2.805

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International Journal OF Engineering Sciences &Management Research

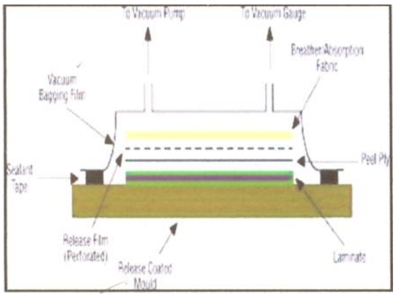

Fig.1.7 Vacuum bag molding process

AUTOCLAVE MOLDING

Autoclave is simply a large, heated pressure vessel. Autoclave molding is similar to vacuum bag process with the exception that the lay-up is subjected to additional pressure, usually up to 7bar and heat is applied to cure the resin. vacuum usually applied during the initial stages of the cure cycle to remove the volatiles and trapped air without causing excessive resin flow. Autoclave pressure may be maintained during the entire heating and cooling cycle.

Fig.1.8 Autoclave molding

CONCLUSION

This paper provides brief introduction about manufacturing process used for fabrication of natural fibre composites. This review also presents history and classification of natural fibre composites.

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