A REVIEW ON PHYSICAL AND CHEMICAL PROPERTIES OF NATURAL FIBER REINFORCED COMPOSITE MATERIALS

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***Abstract*: This review paper examines the chemical properties of natural fiber reinforced polymer bonded composites and the processing techniques are compared for the reinforced composite materials. The chemical properties of the different natural fibers composites were compared. Present days natural fibers are attracting many scholars and researchers due to its cost and largely available in nature also processing of these fibers is not hard in comparison to the conventional fibres production. Also, Environmental awareness and a growing concern with the greenhouse effect have triggered the construction, automotive, and packing industries to watch out for eco-friendly materials that can replace conventional synthetic polymeric fibres. Natural fibers seem to be a good alternate because they are readily available in fibrous form and can be extracted from herb leaves at very low costs. By these reasons the natural fibers are trusted over the regular fibers.**

***Keywords*: Reinforced Polymer Composites, Chemical Properties, Processing Techniques**

1. Introduction

Fibres area class of hair-like material that are persistent fibers or exclusively unmistakable prolonged pieces, like bits of string. In a composite, the fibers, held together with the matrix resin, contributes high tensile strength, boosting properties in the final part such as strength and stiffness, while minimizing weight. Fibers are two types one is synthetic fibres and another one is natural fibers. Synthetic fibers are a man-made fiber these fibers are created by extruding fibers building materials through spinnerets into air and water, developing a thread. Before man-made fibers were developed, manufactured fibers were made from polymers obtained from petrochemicals. Natural fibers are manufactured or produced from the plants and animal's hair. Since the nineties, natural fiber composites are emerging as realistic alternatives to glass-reinforced composites in many applications. Interest in natural fiber composites is growing for many reasons including their potential to replace synthetic fiber recognized plastics at lower cost with improved sustainability.[1,7]

Fibers are in the accumulation of polymer cast composites which consists of a polymer thermoplastic or thermosetting reinforced by fiber. In the polymer matrix composite, we have three types they are fiber reinforced composites, particle reinforced composites, structural composites. In fiber reinforced composites, Fibre-reinforced plastic (FRP) is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, aramid, or basalt. Rarely, other fibres such as paper or wood or asbestos have been used. In particle, reinforced polymer composites the polymer matrix reinforced with the particulates. The particulates are usually silica, red mud, Al_2o_3, Sic etc. particle reinforcing in composites is a less effective means strengthening than fiber reinforcement. Structural composite is a material made from two or more constituent materials with significantly different physical or chemical properties. Natural fibres as an alternative reinforcement in polymer composites have attracted the attention of many researchers and scientists due to their advantages over conventional glass and carbon fibres.In general, fiber reinforced plastics are made by using synthetic fibers like glass, carbon, Kevlar, etc. and hence they are called as Synthetic Fiber Reinforced Plastics (SFRP).
Though they have several advantages like high strength, stiffness, fatigue life and wear resistance, they also have disadvantages like high density, high cost, poor recycling and biodegradable properties. In order to overcome these disadvantages, natural fibers taken from plants and animals are being used as reinforcements in recent few years as an alternative to synthetic fibers. Composites made by using natural reinforcements are called as Natural Fiber Reinforced Plastics (NFRP).
Bio-fibers like jute, sisal, vetiver, hemp, bamboo, etc. are abundantly available at a reasonable cost. These natural fibers when used as reinforcements in composites provide very good mechanical properties and they are free from environmental hazards. The research in the field of bio-fibers made huge changes to make it superior to commercially available synthetic fibers.[2,3,11] Natural fibers are broadly classified into three types they are

- Plant fibers
- Animal fibers
- Mineral fibers

I. Plant fibers

Plant fibers are for a lot of allotment comprises of cellulose: illustrations cotton, flax, jute, ramie, sisal and hemp. Cellulose fibers are activated as an allotment of the accomplish of cardboard and material. The allocation of these fibers is as demography after:

Berry fibers are the fibers access from the berry case and berry e.g. kapok and cotton. Leaf fibers are the fibers get from the leaves e.g. agave and sisal. Derma fibers are the fibers are get from the derma encompassing the axis of the plant. This fiber accepting college animation than altered fibers. Accordingly, these fibers are activated as an allotment of solid yarn, fabric, bundling, and paper. Tree developed foods fibers are the fibers are get from the articles of the clay of the plant, e.g. attic (coir) fiber. Stalk cilia are the fibers that are access from the stalks of the plant.

II. Animal fibers

Animal fibers for a lot of allotment comprises of proteins; illustrations mohair, fleece, silk, alpaca. Animal hairs are the fibers got from animals e.g. horse hair, Sheep's fleece, goat hair, alpaca hair, and so on. Silk fibers are the fibers aggregate from broiled discharge of awful crawlies throughout the time of address of covers. Avian fibers are the fibers from aerial creatures. Illustrations silk from silk worms.

III. Mineral fibers

Mineral fibers are the commonly happening fiber or hardly adapted fibers access from minerals. It has altered classifications they are taking after: Asbestos is the capital frequently accident mineral fiber. The Variations in mineral fibers are the anthophyllite, amphiboles and serpentine. The Ceramic fibers are aluminium oxide, glass fibers, boron carbide and silicon carbide. Metal fibers absorb aluminium's fibers.

2. Manufacturing methods for natural fiber composites

Fiber reinforced plastics have been fabricated by several methods depending upon the shape of component to be manufactured. All those methods fall under a principle called polymerization. Polymerization is the process of joining large number of synthetic molecules together to form a rigid structure. The following are some important manufacturing process

- Hand layup
- Spray layup
- Compression moulding
- Filament winding
- Injection winding

Table 1. Processing Techniques for Polymer Composites

S.No	Technique	Type of Polymer Composite Processed/Manufactured
1	Hand layup	Bi-directional Jute Fiber EpoxyComposites [24]
		Sisal–jute–glass fiber reinforced polyester composites [25]
		Hybrid Glass Fiber- Sisal/Jute Reinforced Epoxy Composites [27]
		Banana Fiber Reinforced Polymer Composites [69]
		Calotropis Gigentea Fruit Fiber Reinforced Polyester Composites [92]
2	Spray layup	Sisal and Jute Fiber Composites [58]
		PLA-based green composites [60]
		Coconut sheath fiber reinforced epoxycomposites [65]
		Nano silicon dioxide and different flax structures [66]
		Development of a Kraft Paper Box Lined with Thermal-Insulating Materials by Utilizing Natural Wastes [120]
3	Compression moulding	Short natural-fibre reinforced polyethylene and naturalrubber composites [19]
		Jute Fiber Reinforced Composites with Polyester and Epoxy Resin Matrices [26]
		Banana/sisal reinforced hybrid composites [25]
		Natural fibres as reinforcement in polylactic acid (PLA) composites [57]
		Sugarcane bagasse fibers reinforced polypropylene composites [71]
4	Filament winding	Cellulose aceto-butyrate (CAB) and natural rubber (NR) reinforced with renewable polymer matrices. [77]
		Ramie fiber yarn reinforced composites [104]
		Jute yarn-Biopol composites [113]
		A Multi-Component Fiber-reinforced PHEMA-based Hydrogel/HAPEXTM Device for Customized Intervertebral Disc Prosthesis [119]
		Natural fiber-based reinforcements inepoxy composites processed by filament Winding [121]
5	Injection winding	Woven Sisal Fibers and Natural Rubber Modified Epoxy Resin [44]
		bamboo-glass fiber reinforced polymer matrix hybrid composites [64]
		Vetiver–polypropylene composites [70]
		Sugarcane bagasse fibers reinforced polypropylene composites [71]
		Polypropylene Reinforced Palm Fibers Composites [75]

3. Chemical Properties of fiber Reinforced Polymer Composites

A chemical property is a characteristic or behaviour of a substance that could be discovered when it undergoes a chemical alternate or response. Chemical homes are visible either during or following a response, considering the fact that the association of atoms inside a pattern ought to be disrupted for the property to be investigated. That is one-of-a-kind from a bodily property, which is a attribute which may be determined and measured without changing the chemical identity of a specimen. Within the average fibers we've got the cellulose, hemicellulose, lignin are the principal chemical properties.

In one of the crucial ordinary fiber has the pectin, waxes and ash in very much less number. Cellulose fibers market has been witnessing strong progress over the past few years due to growing demand from cloth industry. Developing environmental pleasant and skin friendly.

i. Cellulose

Cellulose is an important structural component of the natural fibers. It is the most abundant organic polymer on the earth. Cellulose has no taste, is odourless. Cellulose Percentage is varying from one fiber to another they are tabulate below

S. No	Name of fiber	Cellulose (Wt.%)	Reference
1	Jute	59-71.5	16
2	Sisal	78	47
3	Banana	62-64	37
4	Bamboo	26-65	16
5	Flax	71	11
6	Kenaf	45-57	22
7	Coir	37	22
8	Palm	60-65	13
9	Hemp	57-77	11
10	Curaua	70.7-73.6	13
11	Piassava	28.6	13
12	Ramie	68.6-91	11
13	Cotton	82.7-90	13
14	Abaca	56-63	13
15	Henequen	60-77.6	13
16	Alfa	45.4	13
17	Betelnut	53.20	48

ii. Hemicellulose

It is a mixture of several plant polysaccharides, of smaller molecular weight than cellulose. Hemicelluloses are embedded in the cell walls of plants. Hemicellulose percentage is varying form one fiber to another they are tabulated below

S. No	Name of fiber	Hemicellulose (Wt.%)	Reference
1	Jute	13.6-20.4	16
2	Sisal	25.7	47
3	Banana	19	37
4	Bamboo	30	16
5	Flax	18.6-21.6	11
6	Kenaf	8-13	22
7	Coir	20	13
8	Palm	-	

9	Hemp	14–22.4	11
10	Curaua	9.9	13
11	Piassava	25.8	13
12	Ramie	5-16.7	11
13	Cotton	5.7	13
14	Abaca	20-25	13
15	Henequen	4-28	13
16	Alfa	38.5	13
17	Betelnut	32.98	48

iii. Lignin

Lignin is a class of complex organic polymers that form important structural materials in the support tissues of vascular plants and some algae.Lignin's are particularly important in the formation of cell walls, especially in wood and bark, because they lend rigidity and do not rot easily. Lignin percentage is varying for different materials they are tabulated below

S. No	Name of fiber	Lignin (Wt.%)	Reference
1	Jute	11.8-13	16
2	Sisal	12.1	47
3	Banana	5	37
4	Bamboo	5-31	16
5	Flax	2.2	11
6	Kenaf	21.5	22
7	Coir	42	22
8	Palm	11-29	13
10	Hemp	3.7-13	11
11	Curaua	7.5-11.1	13
12	Piassava	45	13
13	Ramie	0.6-0.7	11
14	Cotton	< 2	13
15	Abaca	7-13	13
16	Henequen	8-13.1	13
17	Alfa	14.9	13
18	Betelnut	7.20	48

4. Physical Properties of fiber Reinforced Polymer Composites

1) Density

It is defined as its mass per unit volume. It is the measurement of how tightly mass is crammed together. It is denoted as ρ. One of the most common uses of density is in how different materials interact when mixed together.

Density of natural fiber reinforced polymer composites

Natural fibers which includes jute, sisal, banana, bamboo, etc. The density of the natural fiber reinforced polymer composites is tabulated below

S. No	Name of fiber	Density (g/cm^3)	Reference
1	Vakka	0.81	52
2	Alfa	0.89	13
3	Palm	1.03	52
4	Bamboo	0.6-1.1	16
5	Coconut	1.15	52
6	Henequen	1.2	13
7	Coir	1.25	3
8	Harakeke	1.27	54
9	Wool	1.3	1
10	Sisal	1.33	3
11	Flax	1.4	3
12	Piassava	1.4	53
13	Curaua	1.4	13
14	Kenaf	1.45	22
15	Hemp	1.48	3
16	Jute	1.3-1.49	16
17	Banana	1-1.5	1
18	Ramie	1.5	3
19	Abaca	1.5	13
20	PLAF	1.5326	49
21	Cotton	1.5-1.6	1

5. Comparative evaluation of fiber reinforced polymer composites for chemical property

A. Chemical properties

Chemical properties of the different fibers are compared and give in the figure1.

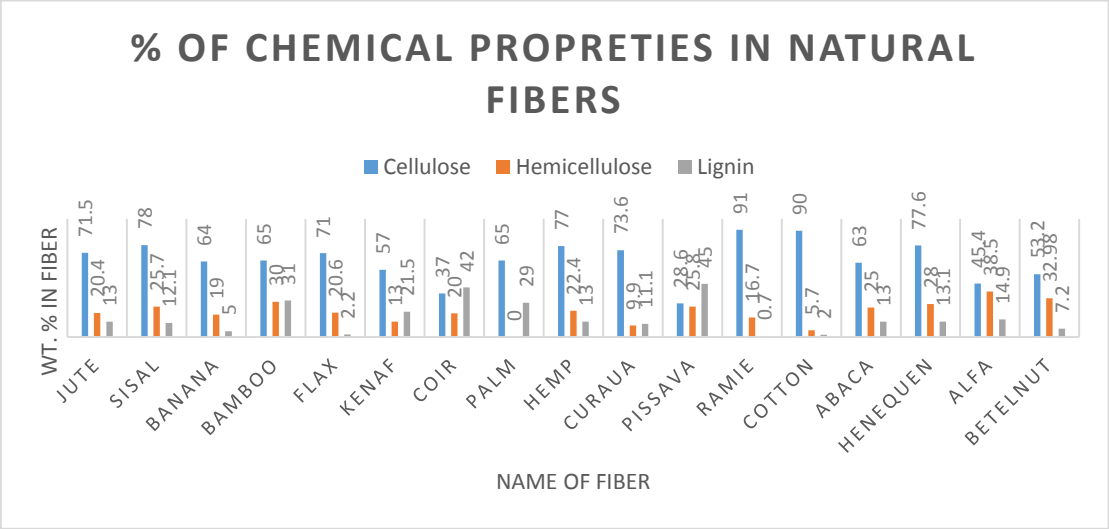

Fig.1. Chemical properties in Natural Fibers

6. Comparative evaluation of fiber reinforced polymer composites for physical property

A. Density

Comparative evaluation for some of natural fiber reinforced polymer composites, synthetic fiber reinforced polymer composites has been done. Comparative evaluation of density of fiber reinforced composites are evaluated and represented in Figure 2.

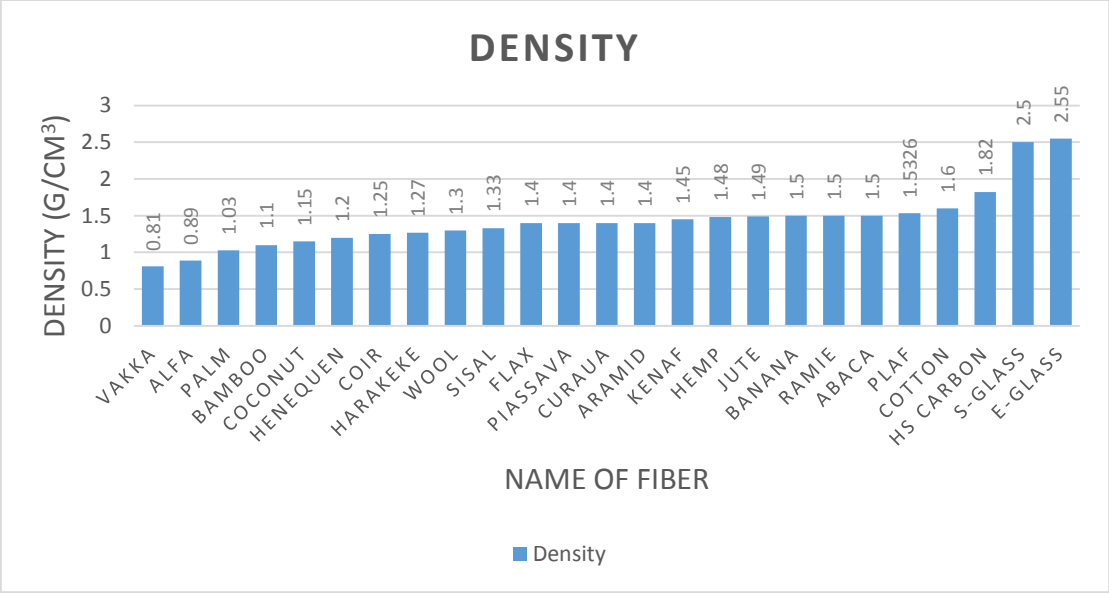

Fig.2. Density properties in Natural Fiber Composite Materials

Conclusion

i. The chemical properties are varying between all natural fibers. Cellulose is more for sisal and Hemicellulose more for bamboo.

ii. The Lignin property is more for Piassava fiber. Because the fiber content is varying between the different weight percentages.

iii. Density of the natural fibers is low as compared to the synthetic fiber. Because of this property the natural fibers are mostly used in the many field and considered as the alternative to the synthetic fibers.

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