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Utilization of Agro Waste (Rice Husk) for Sustainable Engineering Material in Nigeria

[1]Hammajam, A. A, [2]Gujja, A, [3]Ngawaitu, M. B & [4]Usman, I
[1&2]Department of Mechanical Engineering Technology,
Federal Polytechnic Damaturu-Yobe State
[3&4]Department of Mechanical Engineering,
Ramat Polytechnic Maiduguri, Borno State Nigeria

Abstract

Agro waste natural fibers were used in reinforcement of engineering materials for over three centuries. Rice husk fibers were investigated for use in plastics. Agro waste Natural fibers have the advantage that they are renewable resources. The African have been using agro waste natural fibers for many years for reinforcement in northern Nigeria. Natural fibers are increasingly used in automotive and packaging materials in developed and developing countries. Thousands of tons of different crops are produced but most of their wastes do not have any useful utilization. Agricultural wastes include wheat husk, rice husk, and their straw, hemp fiber and shells of various dry fruits. These agricultural wastes can be used to prepare fiber reinforced polymer composites for commercial use. This study examines rice husk fibers availability and the current status of research in Nigeria. Several literature assessments to the latest work on properties, processing and application have been referred in this report.

Keywords: *Rice, Husk, Composite, Agro waste*

Corresponding Author Hammajam, A. A

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Background to the Study

Agro waste and natural fiber composites are not altogether a new phenomenon. The interest in superior material started to grow as a result of environmental safety and industrialization (). Rice husk as waste are abundantly available and has the potential to be used as filler or reinforcement in plastic composites (). Rapid increase in quantity and categories of agro waste as a result of rigorous agriculture in wake of population growth and improve standard of living is becoming dwindling problem as rotten waste emits methane and leachate, and open burning by farmers to clear lands generate carbon dioxide (CO_2) and other local pollutants (). Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in weaker material (known as matrix). Reinforcement provides strength and rigidity, helping to support structural load. The matrix or binder (organic or inorganic) maintains the position and orientation of the reinforcement. Significantly, constituents of the composites retain their individual, physical and chemical properties; yet together they produce a combination of qualities which individual constituents would be incapable of producing alone (). Wood is natural three-dimensional polymeric composite and consists primarily of cellulose, hemicellulose and lignin. In addition, wood is an original and natural composite. The biological world offers other examples of composites in bone and teeth, which are essentially composed of hard inorganic crystals in a matrix of tough organic collagen.

Historical examples of composites [3] are abundant in literature. Significant examples include the use of reinforcing mud walls in houses with bamboo shoots, glued laminated wood by Egyptians (1500 BC) and laminated metals in the forging of swords (1800 AD) (). In the 20th century, modern composites were used in 1930s, where glass fibers reinforced resins. Boats and aircrafts were built out of these glass composites, commonly called fiberglass. Since the 1970s, the application of composites has widely increased due to development of new fibers such as carbon, boron and aramids, and new composite systems with matrices made of metal and ceramics (). Consequently, agro wastes are of high value with respect to material reinforcement, filler and energy recovery. Thus, this study attempt to utilize this waste as alternative filler or reinforcement.

Figure (a) show rice farm and (b) shows rice husk left on milling site

Statement of Problem
Rice husk fiber is an agro waste left on the farm site after harvest. Due to under utilization of this waste, it became houses for micro organisms that harbor diseases and consequently resulted in environmental pollutant.

Objective of the Study
This finding seeks a way of converting this waste into filler/reinforcement for plastic composites applications.

Types of Composites
For the sake of simplicity, however, composites can be grouped into categories based on the nature of the matrix each type possesses. Methods of fabrication also vary according to physical and chemical properties of the matrices and reinforcing fibers.

1. Polymer Matrix Composites (PMCs)
2. Metal Matrix Composites (MMCs)
3. Ceramic Matrix Composites (CMCs)
4. Carbon-carbon composites (CCMs)

Constituents of Composites

1. Matrices
2. Reinforcing Fibers

Polymer resins have been divided broadly into two categories: Thermosetting and Thermoplastics.

Thermosetting
Thermoset is a hard and stiff cross linked material that does not soften or become moldable when heated. Thermosets are stiff and do not stretch the way that elastomers and thermoplastics do (). Several types of polymers have been used as matrices for natural fiber composites. Most commonly used thermoset polymers are epoxy resins and other resins (Unsaturated polyester resins (as in fiber glass) Vinyl Ester, Phenolic Epoxy, Novolac and Polyamide).

Thermoplastics
Thermoplastics are polymers that require heat to make them process able. After cooling, such materials retain their shape. In addition, these polymers may be reheated and reformed, often without significant changes in their properties (). The thermoplastics which have been used as matrix for natural fiber reinforced composites are as follows: High density polyethylene (HDPE), Low density polyethylene (LDPE), Chlorinated polyethylene (CPE), Polypropylene (PP), Normal polystyrene (PS), Poly (Vinyl chloride) PVC), Mixtures of polymers and Recycled Thermoplastics. Only those thermoplastics are useable for natural fiber reinforced composites, whose processing temperature (temperature at which fiber is incorporated into polymer matrix) does not exceed 230°C.

Figure (c) Show High Density Polyethylene (HDPE)

Reinforcing Fibers

The three most common types of reinforcing fibers include fiber glass, carbon and Aramid.

Processing Activities Flow Chart of Composite

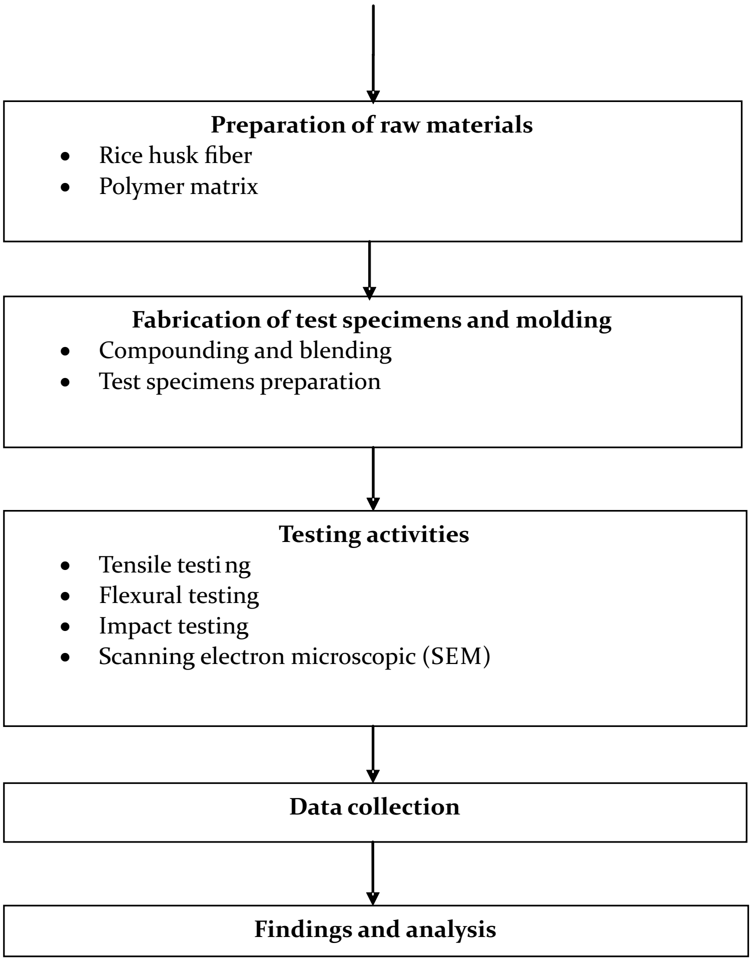

Figure (d): Activities Flow Chart

Natural Fibers

The use of natural fiber for the reinforcement of the composites has received increasing attention both by the academic sector and the industry. Natural fibers have many significant advantages over synthetic fibers. Currently, many types of natural fibers have been investigated for use in plastics including fl ax, hemp, jute straw, wood, rice husk, wheat, barley, oats, rye, cane (sugar and bamboo), grass, reeds, kenaf, ramie, oil palm empty fruit bunch, sisal, coir, water, hyacinth, pennywort, kapok, paper mulberry, raphia, banana fiber, pineapple leaf fiber and papyrus. Thermoplastics reinforced with special wood fillers are enjoying rapid growth due to their many advantages; lightweight reasonable strength and stiffness. Some plant proteins are interesting renewable materials, because of their thermoplastic properties. Wheat gluten is unique among cereal and other plant proteins in its ability to form a cohesive blend with viscous elastic properties once plasticized. For these reasons, wheat gluten has been utilized to process edible or biodegradable films or packing materials. Hemp is a bast lingo cellulosic fiber, comes from the plant *Cannabis sativa* and has been used as reinforcement in biodegradable composites.

Technical Applications of natural Fiber Reinforced Composites

Natural fibers are replacing synthetic fibers as reinforcement in various matrices. The composites so prepared can effectively be used as substitute for wood and also in various other technical fields, e.g. automotive parts. Seventy years ago, nearly all resources for the production of commodities and many technical products were materials derived from natural textiles. Textiles, ropes, canvas and also paper, were made of local natural fibers, such as fl ax and hemp. Some of these are still used today. As early as 1908, the first composite materials were applied for the fabrication of large quantities of sheets, tubes and pipes for electronic purposes (paper or cotton to reinforce sheets, made of phenol or melamine-formaldehyde resins). For example in 1996, aeroplane seats and fuel tanks were made of natural fibers with small content of polymeric binders. The last decade has seen a multiplicity of applications of natural fiber composites due to their impressive properties such as biodegradability and high specific properties. Currently, a revolution in the use of natural fibers, as reinforcements in technical application, is taking place mainly in the automobile and packaging industries (e.g., egg boxes). In the automotive industry, textile waste has been used for years to reinforce plastics used in cars, especially in the Trabant.

The use of natural fibers within composite applications is being pursued extensively throughout the world. Consequently, natural fiber composite materials are being used for making many components in the automotive sector.

These materials are based largely on polypropylene or polyester matrices, incorporating fibers such as flax, hemp, and jute. Thus in the future cars may be molded from cashew nut oil and hemp. Even golf clubs may be built around jute fibers, and tennis racket may be stiffened with coconut hair. Bicycle frames may derive their strength from any one of the 2000 other suitable plants. The high-tech revolution in use of natural fibers could end in replacement of synthetic materials.

The diverse range of products now being produced, utilizing natural fibers and biobased resins derived from soybeans, is giving life to a new generation of biobased composites for a number of applications. These include not only automotive vehicles (including trucking) but also hurricane-resistant housing and structures, especially in the United States. The construction sector and the leisure industry are some of the other areas where these novel materials are finding a market. In Germany, car manufactures are aiming to make every component of their vehicles either recyclable or biodegradable.

Future Application

In order to be environment friendly, automotive engineers have now developed a concept car, the Eco Car. It is expected to be the sustainable vehicle for the future, running on biofuels. It uses natural fiber composite panels where biodegradable resins have been incorporated as the matrix material. It has been recently predicted that the most important technologies of the future that incorporate natural fiber composite materials will be natural fibers for injection moulded products (32%) followed by natural fibers with a bioplastic matrix (19%) and modified fibers for use in advanced applications (19%).

Figure (e) show agro waste polymer composite

Figure (f) shows agro waste composite mechanical properties test specimens

Figure (g) universal testing of mechanical properties of agro waste composites

Conclusion and Recommendation

Natural fibers, when used as reinforcement, compete with such technical fibers as glass fiber. The advantages of natural fibers are good mechanical properties; which vary only little, while their disadvantage is difficulty in recycling. Several natural fiber composites reach the mechanical properties of glass fiber composites, and they are already applied, e.g., in automobile and furniture industries. Till date, the most important natural fibers vary in area of applications. Thus, rice husk fibers if put into proper use could save costs and environment in term of engineering functions.

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