Evaluation of Hardness on Varying Oven Drying Temperature for Acetic Anhydride Concentration of Raffia Palm Fibre

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***Abstract*: The aim of this research is to study the hardness on varying oven temperature for acetic anhydride concentration in raffia palm fibre. Raffia palm is a natural fibre with their long history of serving mankind, are very important in a wide range of applications, and they compete and co-exist in the twenty-first century with man-made fibres, especially as far as quality, sustainability and economy of production are concerned. The matured raffia palm fibre was cut, gathered, extracted, retted, dried, treated and modified. The fibres were thoroughly washed to neutrality and oven-dried at various temperatures at different fibre length for the modified fibre. After the fibre was dried, the mercerized fibre was treated with acetic anhydride solution at 5% with soaking time of 60 minutes (1 hour) at three acetylation temperatures of 30° C, 50° C, and 70° C with varying fibre length of 50 mm, 60 mm, 70 mm and 80 mm. The results of hardness test conducted on the 5% Acetic Anhydride concentration for three oven drying temperature using different fibre length for modified fibre, shows the optimum hardness of 370 HB at 60 mm fibre length using 50° C oven drying temperature. While at 277 HB also showed reasonable hardness at 70° C using 60 mm fibre length and 185 HB at oven drying temperature of 30° C using 80 mm fibre length. Therefore, the hardness of 370 HB at 60 mm fibre length using 50° C oven drying temperature gave the highest value and the research benchmark. The result shows increase in hardness with treatment of fibre. Usually, modified fibre specimens possess higher hardness. Incessantly, these brittle and hard fibres will oppose deformation due to indentation. Natural fiber composites have gained increase value in the production of oil and gas, offshore, onshore facilities like pipes and piping system and pressure vessel.**

***Keywords*: Acetic Anhydride, Concentration, Oven Bath Temperature**

1. Introduction

Natural fiber composites are group of composite materials in which the reinforcing fibers originate from renewable and CO_2 neutral resources either wood or plants. NFC can be produced with many of the manufacturing methods that are traditionally used for conventional composites and thermoplastics such as resin transfer molding, vacuum infusion, compression molding, direct extrusion and compounding and injection molding. Different constituents result in composite materials with diverse properties as well as different manufacturing techniques. Thus, the properties of NFC can be tailored for various types of applications by a proper selection of fibers, matrix, additives and manufacturing method. For many decades, injection molded thermoplastics with and without fillers have been developed [1]. The natural fibre has been applied in many areas ranging from small door knobs and high-performance car parts and gaskets to furniture. Natural fiber compounds offer numerous advantages over other injection molding compounds, for instance, low wear of manufacturing tools, often reduced cycle time and ease of recycling. Energy can be recovered by incineration with hardly any ash residue is one large advantage compared to thermoplastics filled with mineral fillers [2]. The biggest disadvantages of NFC concern their outdoor durability, temperature, effects of humidity, UV etc. Different routes to improve these properties are proposed and implemented continuously [3]. The problems can be handled but may affect the cost of the NFC compounds negatively. Still there are many applications which are not subjected to high moisture levels, UV or temperature changes i.e., indoor applications, where less expensive formulations of NFC can be used and reduce material costs compared to most thermoplastic compounds. However, the major driving force behind a switch from fossil based to renewable reinforcement and/or fillers would most likely be sustainability. The total consumption of thermoplastics in Western Europe alone was approximately 38 million tons in 2003 [4]. Even if only some percentages of the thermoplastics can be replaced by renewable fibers it would be a significant reduction of the use of fossil resources. Conventional high-performance composites contain long, mostly continuous filaments such as glass or carbon fibers. Natural fiber fabrics have been developed for technical applications [5], the main part of the NFC out on the market contain short fibers. In some types of synthetic short fiber composites (SMC, BMC, GMT) the fiber length remains the same throughout the processing stages. But for some processes, like compounding and injection molding, the fiber length is process-dependent i.e., the initial fiber length will not be preserved in the final product. Since fiber length is one of the most important parameters in terms of mechanical performance of short fiber composites [6], degradation of fiber length during processing has been extensively studied [7, 8].

2. Materials and Methods

2.1 Materials

The following materials were used to conduct this study, they are fibre extracted from the raffia palm (Figure 1). Other materials used are graduated cylinder, electric oven, plastic cup, plastic bucket, pH meter, electronic weighing scale, glass beaker, distilled water etc.

Figure 1: Raffia Palm Fibre after Extraction

2.2 Methods

The matured raffia palm fibre was gathered, extracted, retted, dried, treated and modified. After the fibre was dried, the mercerized fibre was treated with acetic anhydride solution at 5% with soaking time of 60 minutes (1 hour) at varying temperatures at different fibre length. The fibres were thoroughly washed to neutrality and oven dried at various temperatures at different fibre length for the modified fibre. Hardness was determined after the treatment and results obtained on the hardness test were recorded and analyzed.

- **Fibre Treatment**

The fibres were modified using 5% concentration of acetic anhydride solution at three acetylation temperatures of 30° C, 50° C, and 70° C with varying fibre length of 50 mm, 60 mm, 70 mm and 80 mm.

- **Hardness Test**

The resistance to permanent deformation, indentation or scratching is called hardness. The values of hardness of the fibre samples developed were measured using Rockwell Hardness Tester on MScale by ASTM D785. The results of the hardness test were also recorded.

3. Results and Discussion

The results of the hardness test conducted on these modified fibres are presented in the tables 1 to 3. The results and analysis of the hardness tests are shown with a bar chat in figures 1 to 3.

Table 1: Fibre Hardness at 5% Acetic Anhydride Concentration for Oven Drying Temperature of 30° C at Different Length for Modified Raffia Palm Fibre

Fibre Replication/Length	Hardness (HB) at			
	50 mm	60 mm	70 mm	80 mm
R1	133	124	130	120
R2	168	84	181	185
R3	152	103	177	104
R4	151	104	163	131
R5	146	110	155	172

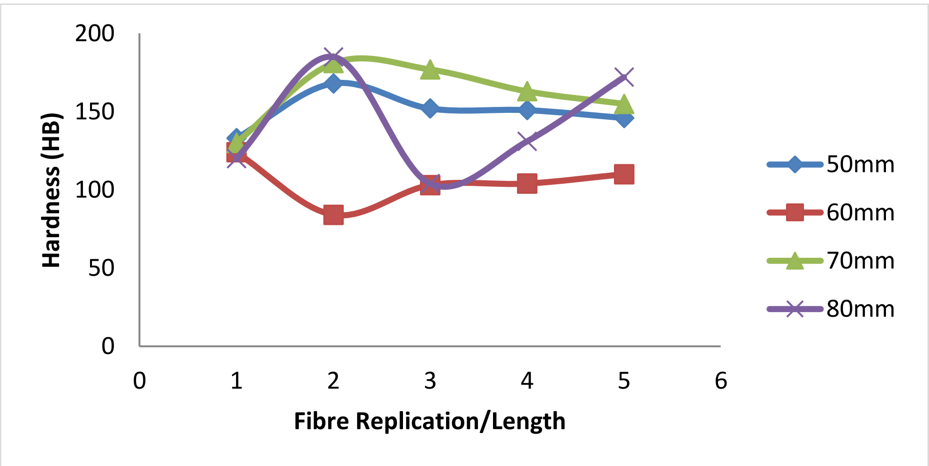

Figure 1: Graph of Hardness at 5% Acetic Anhydride Concentration for Oven Drying Temperature of 30° C using Different Fibre Length for Modified Raffia Palm Fibre

Table 2: Hardness at 5% Acetic Anhydride Concentration for Oven Drying Temperature of 50° C using Different Fibre Length for Modified Raffia Palm Fibre

Fibre Replication/Length	Hardness (HB) at			
	50 mm	60 mm	70 mm	80 mm
R1	153	157	89	82
R2	199	196	144	157
R3	145	370	119	113
R4	166	241	117	117
R5	145	182	125	132

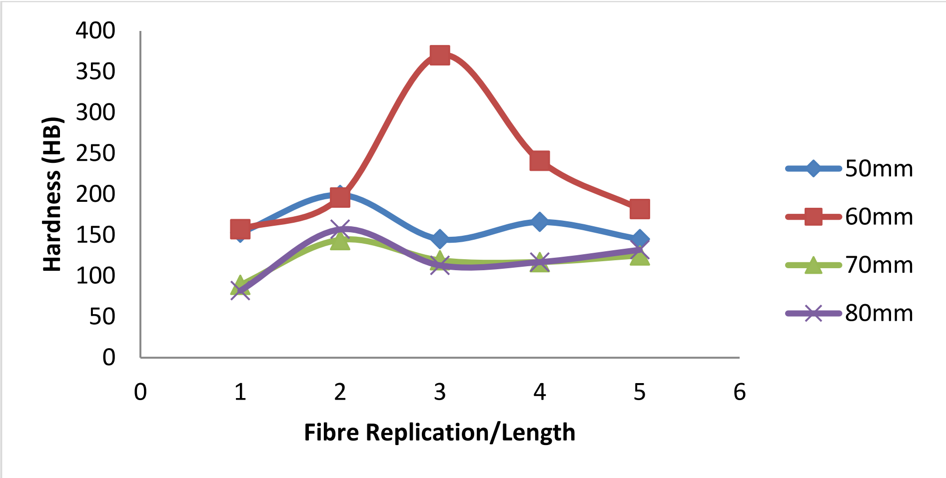

Figure 2: Graph of Hardness at 5% Acetic Anhydride Concentration for Oven Drying Temperature of 50° C using Different Fibre Length for Modified Raffia Palm Fibre

Table 3: Hardness at 5% Acetic Anhydride Concentration for Oven Drying Temperature of 70° C using Different Fibre Length for Modified Raffia Palm Fibre

Fibre Replication/Length	Hardness (HB) at			
	50 mm	60 mm	70 mm	80 mm
R1	88	117	115	100
R2	152	174	183	89
R3	152	277	163	161
R4	131	189	154	111
R5	145	210	174	128

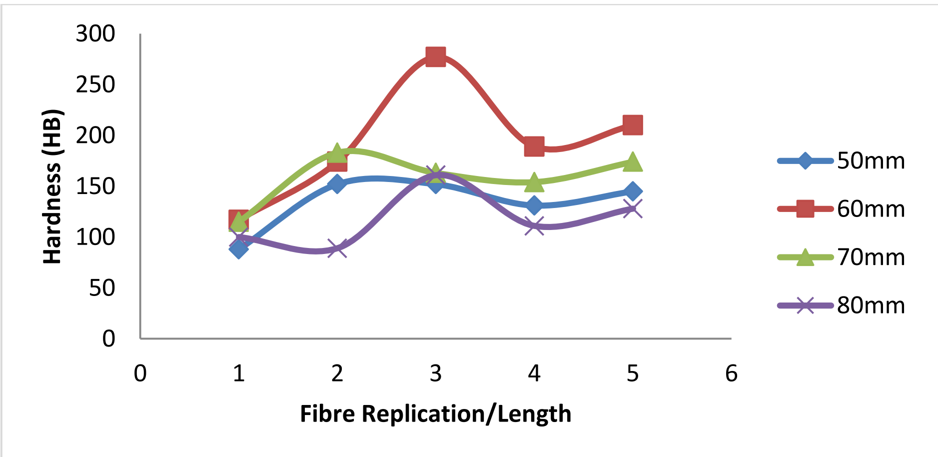

Figure 3: Graph of Hardness at 5% Acetic Anhydride Concentration for Oven Drying Temperature of 70° C using Different Fibre Length for Modified Raffia Palm Fibre

The results of hardness analysis obtained from the test conducted on the 5% Acetic Anhydride concentration for three oven drying temperature using different fibre length for modified fibre, shows that the optimum hardness of 370 HB at 60 mm fibre length using 50° C oven drying temperature. While at 277 HB also showed reasonable hardness at 70° C using 60 mm fibre length and 185 HB at oven drying temperature of 30° C using 80 mm fibre length. Therefore, the hardness of 370 HB at 60 mm fibre length using 50° C oven drying temperature gave the highest value and the research benchmark. The result shows increase in hardness with treatment of fibre. Usually, modified fibre specimens possess higher hardness. Incessantly, these brittle and hard fibres will oppose deformation due to indentation.

4. Conclusion

Polymer composites can contain fibers of different origin with diverse properties. Fiber selection is normally based on the requirements of the final product. In applications like electrical insulators and boat hulls, mineral fibers are often used. PAN fibres are used in the production of Carbon fibers, which are used in aerospace and sports goods applications and so forth. Carbon, glass and other conventional reinforcement materials are available as continuous fibers in roving or fabrics of various types, or chopped in mats. The properties of these reinforcements are well defined and documented systematically. Fibers from a natural regenerating resource are called natural fibres (i.e., a plant or a tree), are not used for load bearing structures to any large extent today. The fibers are usually only a few millimeters up to couple of centimeters long. They can be used for structural applications if these can be spun to roving and weaved to fabrics. If specific properties are considered, their properties are comparable to synthetic fibers in some regard. Application of natural fiber composites and performance have gained increase in value in oil and gas, offshore and various applications due to low cost, light weight, stiffness, competitive specific strength, improvement in energy recovery, flexibility and friendliness to the environment as well as their renewable nature.

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