Effect of Oven Drying Temperature on the Tensile Strength for Untreated Raffia Palm Fibre

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Abstract: The aim of this study is to investigate the effect of oven drying temperature for strength of untreated fibre at varying length of fibre. After extraction and retting, the fibres were drained and they were dried in the sun for some hours. After some time, the untreated fibre was dried in electric oven at various temperature of thirty, fifty and seventy degree for 2 hours to achieve zero moisture content. The tensile strength for unmodified fibre at different temperature of thirty, fifty and seventy degree at different length of fibre using 50mm, 60mm, 70mm and 80mm were investigated. The result shows that drying temperature of 30°C gave 717 Mpa at different fibre length of 80mm while for 50°C drying temperature gave 741Mpa at fibre length of 80mm. But oven drying temperature of 70°C has the maximum strength of 752Mpa at 70mm fibre length. Hence, from the result, the oven drying standard temperature for these fibres will be at 70°C. Therefore the drying temperature of seventy degree is accepted for the fibre development in this study. The fibres that were developed were reinforced with polymer to produce test samples and different oil and gas facilities like pipe and piping system and tanks among others.

Keywords – Raffia Palm Fibre, Oven Drying, Tensile Strength.

1.0 Introduction

Motivated by the desire to help promote long-term prosperity for struggling communities in developing countries, this research seeks to uncover novel uses for materials found in abundance among these communities. The hope is that with the right applications, the developing country may obtain the chance to enter the global market with a highly abundant and profitable export (Patrick, 2016). There is also a motivation for this research to develop modern yet sustainable materials that will be available and useful both now and in the future. At the intersection of these motivations lie natural fiber-reinforced thermoplastic composites, where the natural fiber studied comes from the raffia palm fibre. Fibre-reinforced plastics (FRP) have recently been applied to different engineering applications where stiffness and high strength are required (Alberto, 2013). The great success of this technology (or material) is due to the good specific (i.e. weight-related) properties arising from the applied matrix systems low density (unsaturated polyesters, polyurethanes, phenolic or epoxy resins) and from the embedded fibres, that gave raise to high strength and stiffness. Hence, more attention has been given to study the benefit of natural fibres, like raffia palm, abaca, bamboo, jute, ramie, flax, sisal and hemp to replace fibre from wood and other reinforcement's materials like glass fibre (Alberto, 2013). Natural fibres offer many benefits like biodegradability, low pollutant emissions, low cost, low density and high specific properties. Application of natural has been applied in automotive industry and other transportation areas such as trains, marine etc (Alberto, 2013). A key factor driving the increased applications of composites over the recent years is due to development of new advanced forms of FRP materials. NFRC like Glass, Kevlar, boron, carbon fibers are reinforced materials in fiber-reinforced plastics, and this have made them useful structural material and non-structural material used in various application (Ramires et al., 2013). Natural fibers extracted out of plants like the raffia palm, bamboo, coir, jute, sisal and pineapple has high strength and can be used for various load-bearing applications. Natural fibers have the ability of forming various aggregates and therefore, the fibre and matrix surface should be wetted appropriately in order to remove any impurities and improve interfacial adhesion (Rout et al., 2001). The aim of this study is to examine the oven drying effect on strength for untreated raffia palm fibre.

2. MATERIALS AND METHODS

2.1 MATERIALS

This study was investigated using different materials such as fibre from raffia palm from a river called Ngolo in Ikwerre local government area Port Harcourt, River State. Other materials used are Weighing balance, electric oven, distilled water, pH meter, thermometer, beaker, graduated cylinder, plastic cup were also used and so on.

2. 2 METHODS

2.2.1 Water Retting and Fibre Extraction

After the fibre extraction, they were retted which is a rotting process of soaking the fibre in water. In order to process and develop the fibre, they were cut out from the tree trunk and removed manually out of the remnant binders and the fibres are washed with 2% detergent to clean impurities and pectin, hemicelluloses, oily substances on the fibre surface. Later they were drained and dried in the sun before taken to electric oven were they were oven-dried at different temperature of 30, 50 and 70^{o}C for 2 hours. Figure 2.1 shows the fibers after cleaning and drying.

Figure 2.1: Raffia palm fibers after cleaning and drying (Fadele, 2017)

- **Fibre Characterization**

The fibers behavior can be fully understood by conducting mechanical tests. Tensile test for untreated fibre using three oven temperatures of 30, 50 and 70^{o}C with different length of fibre were studied.

- **Tensile Testing**

Tensile tests were conducted for the fibre replicate samples using Hounsfield Monsanto Tensometer with model-H20 KW with magnification of 4:1 and 31.5kgf beam force. The cross head speed is 1 mm/min. In accordance to ASTM D638, the fibres were prepared for tensile test. Each specimen was loaded to failure. The equipment was used to plot the force - extension curve automatically. From the plot, the ultimate tensile strength of the samples was thereafter determined. For each batch of untreated fibers five replicate samples were tested. The results for tensile strength of untreated fibre were recorded using three oven drying temperature of 30, 50 and 70^{o}C at varying fibre length of 50, 60, 70, 80mm.

3. RESULTS AND DISCUSSION

The results of tensile strength for the untreated fibre using varying fibre length of 50, 60, 70, 80mm and oven temperature of 30, 50 and 70^{o}C were analyzed.

Table 1: Tensile Strengths @ 30°C oven drying temperature at varying fibre length

Fibre Replication	Tensile Strengths (Mpa) @50mm	Tensile Strengths (Mpa) @60mm	Tensile Strengths (Mpa) @70mm	Tensile Strengths (Mpa) @80mm
R1	448	645	431	603
R2	491	620	375	536
R3	457	375	478	717
R4	465	547	428	619
R5	435	420	399	612

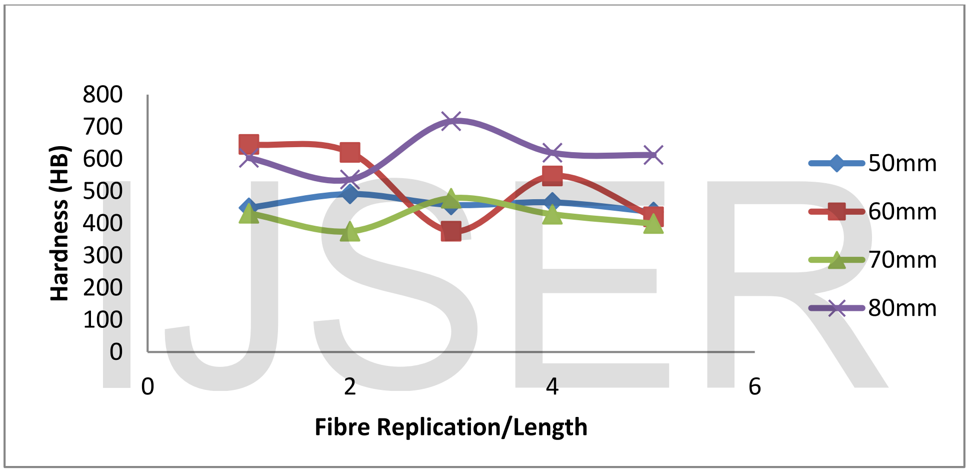

Fig. 1: Graph of strength for 30°C oven drying temperature for untreated RPFs

Table 2: Tensile Strengths @ 50°C oven temperature at varying fibre length

Fibre Replication	Tensile Strengths (Mpa) @50mm	Tensile Strengths (Mpa) @60mm	Tensile Strengths (Mpa) @70mm	Tensile Strengths (Mpa) @80mm
R1	506	598	590	483
R2	614	487	611	594
R3	578	740	522	741
R4	566	608	574	606
R5	530	498	509	450

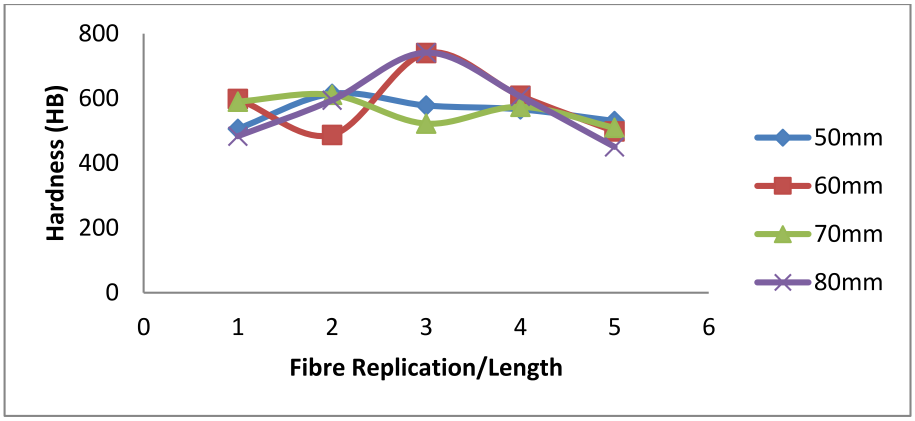

Fig. 2: Graph of strength for 50°C oven drying temperature for untreated RPFs

Table 3: Tensile Strengths @ 70°C oven drying temperature at varying fibre length

Fibre Replication	Tensile Strengths (Mpa) @50mm	Tensile Strengths (Mpa) @60mm	Tensile Strengths (Mpa) @70mm	Tensile Strengths (Mpa) @80mm
R1	529	456	386	462
R2	550	559	625	499
R3	415	434	752	429
R4	498	483	588	463
R5	510	525	560	410

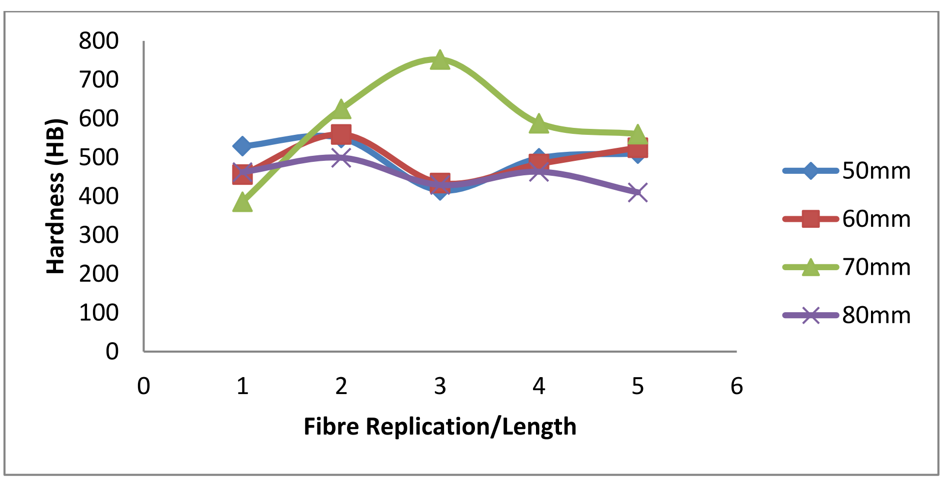

Fig. 3: Graph of strength for 70°C oven drying temperature for untreated RPFs

Based on the experimental results recorded from the oven drying temperature effect of untreated fibre on strength for the material under development, from table 1-3: the result shows that at

30^oC oven drying temperature gave 717 Mpa at varying fibre length of 80mm while for 50^oC oven drying temperature of the fibre gave 741Mpa at fibre length of 80mm. Oven drying temperature of 70^oC gave the highest maximum strength of 752Mpa using fibre length 70mm. From the result, the standard oven drying temperature for these raffia palm fibre will be at 70^oC. Therefore for this raffia palm fibre development, the oven drying temperature of 70^oC is adopted. High density polyethylene (HDPE) can be reinforced with the developed fibre to manufacture samples used for various testing and to produce product system used in oil and gas industries.

4 CONCLUSION

Natural fibre like raffia palm has excellent potential resource for reinforcement due to its abundance; as an agricultural product and they have good mechanical properties. The major challenges in manufacturing and developing natural fiber are the existence of poor bonding between the hydrophobic polymer matrix and the hydrophilic natural fibers. This research studied the different oven drying temperature effect on strength for the fibre. The extraction, processing, oven drying and tensile strength for the raffia palm fibre were studied. The fibre developed with high density polyethylene (HDPE) can be reinforced for the production of test samples to manufacture oil and gas product system using injection molding machine with different mold design to produce pipes joints, storage system and so on.

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