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The effects of the alkaline treatment's soaking exposure on the tensile strength of Napier fibre

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Abstract

The effects of soaking time during the alkaline treatment on the tensile strength of Napier grass fibre and its morphology are discussed. The fibres were treated with 10% of Sodium Hydroxide (NaOH) concentration solution at different soaking times exposure; 3, 6, 12, 18 and 24 hr. The single fibre tests were then performed in accordance with ASTM D3822-07 standard. The surfaces of the fibres prior and after the treatment were observed with a metallurgical Microscope MT8100. The results show that the fibre subjected to 6 hr NaOH treatment yields the maximum tensile strength, albeit lower elastic modulus. Morphology study on the other hand found that the fibre became rougher after treatment with 18 and 24 hr of soaking resulted in severe surface damage of the fibre.

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1. Introduction

"*Napier grass*" (*Pennisetumpurpureum*) is a plant with an interesting source of fibres which originally from Brazil[1]. Napier grass can grow well with limited nutrient for growth. It can mature in a short time between 3–4 months after planting and can continue to grow at an interval of 6–8 weeks up to 5 years [2]. It contains high fibre composition which can be up to 40%. To date, few studies on Napier grass fibres have been conducted by researchers while a serious in-depth study about it is still ongoing [3]. Tremendous progresses have been made in recent years in the development of materials from agricultural crops based fibres. In search to find substitutes for non-biodegradable-manmade fibres, researchers continue to explore the suitability and more importantly durability of natural fibres as reinforcing materials in many composite engineering applications. Liu et al. and Rao et al. found

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that the natural fibres have high potentials to be used as alternative to non-biodegradable glass and carbon fibres in production of thermosetting or thermoplastic composites[4][5].

Alkaline treatment was found to have positive effects on the natural fibres. The resulted rougher surface of the fibres provides better mechanical interlocking with the resin system hence stronger interfacial strength between them. Through study conducted by others, they have reported improvements in mechanical properties of natural fibres when undergoes alkalization process for different soaking periods and at different concentrations. Reddy et al. reported degradation in thermal and tensile properties of alkali treated (up to 5%) Napier grass fibres [3]. Murali Mohan Rao et al. later reported the investigation on the tensile properties of Indian grown Napier grass fibres extracted through chemical and water retting processes [5]. The higher strength and abundant availability of Napier grass fibres have been the prime reasons for the choice of these fibres for the study [6]. Bachtiar et al. on the other hand reported that the alkaline treatment improved the tensile properties of sugar palm fibre reinforced epoxy composites. However further increment of the alkaline concentration and soaking periods reduces the tensile strength due to severe damages to the fibres [7]. Haameem et al. also reported 10% of alkaline treatment of Napier grass fibre yield highest strength compared to untreated fibre [8]. They went further and investigated the tensile strength of the Napier grass fibre/polyester composites. They results indicate a good potential uses of Napier grass fibres in composite applications[9].

The main aim of this paper is to examine the effects of soaking time during alkaline treatment to the tensile strength of the Napier grass fibre. The mechanical properties and surface morphology were then analyzed and discussed.

2. Experimental Procedure

2.1. Extraction of the fibres

Napier grasses were harvested from a local plantation in Bukit Kayu Hitam, Kedah located in north of Peninsular Malaysia. The fibres were manually extracted from grass internodes after subjected to water retting process. Initially the stems were cleaned and crushed using a mallet to separate the fibres strands. Subsequently, the short grass stems were immersed in a running tap water for a few weeks to facilitate the separation process. Finally the fibre strands were cleaned using distilled water and dried under the sun to ensure removal of moisture content of the fibres.

2.2. Alkaline Treatment

The processed Napier grass fibre strands were then treated with 10% aqueous solutions of NaOH at room temperature for 3, 6, 12, 18 and 24 hr, maintaining the liquor ratio 40:1 to remove the hemicelluloses and surface impurities of the fibre. Finally, the fibres were cleaned using distilled water and dried at room temperature.

2.3. Physical Properties

The physical properties of the treated and untreated fibres are presented in Table 1. The measurement of the mass, length, and diameter were taken prior to the tensile test to ensure the properties of the specimens were maintained for analysis purpose. The main aim of the alkaline treatment is to remove amorphous components and reduce hemicelluloses fraction, thus enhancing the strength of fibres [10]. Table 1 shows the gauge lengths of treated fibres are 136 mm and untreated fibre is 165 mm. The mass of the treated fibres are in between 0.004 g to 0.01 g while for untreated fibre the mass recorded was 0.002 g. The ranges of average diameter of the fibres are 0.15 mm to 0.27 mm.