THE EFFECT OF ALKALINE TREATMENT ON THE MECHANICAL AND PHYSICAL PROPERTIES OF KENAF FIBRE REINFORCED VINYL ESTER COMPOSITES

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DECLARATION

I declare that this thesis entitled “The Effect of Alkaline Treatment on The Mechanical and Physical Properties of Kenaf Fibre Reinforced Vinyl Ester Composites” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : ……

Date : ……

APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfilment of Bachelor of Mechanical Engineering with Honors (Structure & Materials).

Signature : .....

Name of Supervisor : .....

Date : .....

ABSTRACT

Natural fibre nowadays having a high demand in any application development. The purpose in usage natural fibre in worldwide application is one of alternative way in order to replace the manufacturing using synthetic fibre. Natural fibres have many advantages including having low cost and easy to process. Next, the greenhouse effect, pollution percentages that occur and health hazard of human, flora and fauna should be reconsidering in any production requirement and become the main reasons natural fibre demand is rising dramatically. Despite that, the terms of polymer matric composites or known as PMCs, using natural fibre as reinforce agent are trending in aeronautic nor automotive industries. Hence, this research is focusing on the effect of chemical treatment kenaf fibre reinforced vinyl ester composites. As the experiment is done, the result data show that treated natural fibre have well in strength, modulus and also physical properties such as water absorption. From flexural experiment data by comparing with untreated, the strength of treated natural fibre improve at 55.46% while for modulus increase at 83.87%. Other than that, the strength distribution of fibre also has a good improvement after conduct tensile test and giving tensile stress of treated is better compared with untreated composites with increasing around 10.93%. For water absorption, the result shows that the treated kenaf fibre can resist water better than untreated one. The surface modification towards natural fibre using alkaline treatment really prove that it has good result compared to untreated natural fibre in terms of enhancement mechanical interlocking between natural fibre and matrix and reduction of chemical content of natural fibre that can reduce the natural characteristic which is hydrophilic.

ABSTRAK

Serat semulajadi pada masa kini mempunyai permintaan yang tinggi dalam pembangunan ekonomi. Tujuan penggunaan serat semulajadi dalam aplikasi di seluruh dunia adalah salah satu cara alternatif untuk menggantikan pembuatan menggunakan serat sintetik iaitu serat yang diperbuat dan digubal oleh manusia. Serat semulajadi mempunyai banyak kelebihan termasuk kos yang rendah dan bahannya juga yang mudah diproses. Seterusnya, kesan rumah hijau, kadar peratusan pencemarah yang berlaku serta tahap kesihatan manusia, flora dan fauna juga harus dipertimbangkan dalam setiap pengeluaran yang telah diproses dan secara tidak langsung menjadikan serat semulajadi salah satu bahan yang menjadi permintaan yang tinggi. Walaubagaimanapun, terma komposit matrik polimer (PMC) yang menggunakan serat semulajadi sebagai agen pengukuhan sedang giat berjalan dalam industri aeronatik mahupun automotif. Oleh itu, kajian kesan rawatan permukaan gentian serat kenaf ini telah mendapat tumpuan yang lebih terperinci. Apabila percubaan dilakukan, hasil data menunjukkan bahawa gentian asli yang dirawat mempunyai kekuatan fizikal, kekuatan modulus dan sifat fizikal seperti penyerapan air yang baik berbanding yang tidak dirawat. Daripada eksperimen lenturan jika dibandingkan dengan yang tidak dirawat, kekuatan serat semulajadi yang dirawat meningkat pada 55.46% manakala peningkatan modulus pada 83.87%. Selain itu pengagihan kekuatan terhadap serat juga mempunyai peningkatan yang baik selepas menjalankan ujian tegangan dengan penambahan sebanyak 10.93%. Untuk eksperimen penyerapan air, hasil menunjukkan bahawa serat kenaf yang dirawat dapat mengahalang penyerapan air dengan lebih baik. Rawatan permukaan ke serat semulajadi menggunakan rawatan alkali benar-benar mebuktikan bahawa ia boleh mendapat hasil yang baik berbanding permukaan yang tidak dirawat dari segi mekanisme hubungkait antara rangkai serat dan juga matriks selain dapat mengurangkan juga kadar kimia dalam serat semulajadi dimana salah satunya adalah hidrofilik.

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LIST OF ABBREVIATIONS

Abbreviation	
CMCs	Ceramic Matrix Composites
MMCs	Metal Matrix Composites
PMCs	Polymer Matrix Composites
FRP	Fibre Reinforced Polymer
UV	Ultraviolet
PVC	Polyvinyl Chloride
PP	Polypropylene
PE	Polyester
VE	Vinyl Ester
VARTM	Vacuum Assisted Resin Transfer Molding
NaOH	Sodium Hydroxide
ASTM	American Society for Testing Materials
SEM	Scanning Electron Microscope

LIST OF SYMBOLS

Symbol	
σ	Tensile Strength (MPa)
F	Force (N)
V	Volume (m^3)
m	Mass (g)
A	Area (m^3)
ρ	Density (g/m^3)

CHAPTER 1

INTRODUCTION

1.0 Overview

In this modernization of modernity, Malaysia is trying to rise up in parallel with developed countries by way of applying green technology in every sector of marketing and production. Green technology is known as technology that can be recycled or reversed and also to develop products, equipment and system used to conserve the natural environment and resources which minimize and reduce the negative impact of human activities. This way is to reduce the percentage of pollutions in Malaysia in considering the green house effects in every aspect that had been taken. Green technology subject areas covered energy, green building, environmentally preferred purchasing, green chemistry and green nanotechnology.

The famous case in Malaysia which to convert the usage of metals and synthetic fibre to natural fibres. Nowadays, synthetic fibres like glass, carbon and aramid are widely being used as polymer-based composites as the properties is strong and the stiffness tendency is high. However, these fibres have serious weakness in terms of their biodegradability, initial processing costs, recyclability, energy consumption, machine abrasion, health hazards and etc. Despite these, most significantly, environmental negative impacts change the attention from synthetic fibres to natural/renewable fibres. The introduction of natural fibres usage from annually renewable resources are now popularly used as reinforcements in polymer matrix. These provide benefits to the environment with obey the terms of the degradability

and utilization of natural materials. The successful use of these fibres is dependent on their best structural and mechanical properties (Kabir *et al.*, 2012).

In industry mostly is looking for "greener material (renewable sources) to use in its products to reduce the burden and as a way to a growing environmentally conscious market. Particularly, in automotive production are looking for products that are much lighter, eco-friendly and low cost. An advantage for using natural fibre compared to glass fibre is their renewable nature and inherent biodegradability, rendering the issue of recyclability meaningless. The leading of using natural fibre reinforced plastics in automotive construction are become legal in many countries (Furtado, Silva and Alves, 2012).

Kenaf is the most comparatively commercially available and economically cheap amongst other natural fibre reinforcing material. Customarily kenaf symbolized as industrial due to of its great interest for the production of industrial raw materials. Kenaf fibre or known as Hibiscus Cannabinus species where genius is Hibiscus and the family Malvaceae obtained from stems of the plants. Kenaf is wild dicotyledons plant of subtropical and tropical parts of Asia. The Persian origin explaining that kenaf the plant having short day, warm season and annually herbaceous plant, with the average diameter of fibre is 67.6 μm. The properties of kenaf are hard, strong and tough plant with a fibrous stalk, resistant to insect damage and requires relatively fewer amount of or no pesticides (Saba, Paridah and Jawaid, 2015).

This study discusses the mechanical, chemical and physical properties characteristic of kenaf fibre composites comparing it with other type of natural fibres as an example PALF (Pineapple Leaf Fibres). In this research which kenaf fibres was treated using alkali solution, NaOH (Sodium Hydroxide) to get the better result in mechanical and physical properties of the fibres.

1.1 Problem Statement

Natural fibre composites are being the top main of research nowadays. As researchers and scientists trying to overcome the disadvantages of kenaf fibres.

Recently, the usage of natural fibres in sector of automotive, construction, sports and leisure, and other mass production industries composite component was focusing on sustainable and renewable reinforced composites. The addition of reinforcements, such as fibres and fillers into polymer composites meaning that by extending the usage of fibres and improvise the properties of component of the composites parallel with the requirements of engineering application. The effects of these improvements will be associated with economic advantages, such as low production costs and low resin consumption. As a result, for the past few years, various commercial applications in the industrial sector was demanding for natural fibres in their usage components production. (Akil *et al.*, 2011).

Natural fibres have a lot of advantages which one of the advantages is can protect green house of earth and directly prevent the pollutions that often happen. However, one of the disadvantages is the dimension of the kenaf are not stable due to the hydrophilic properties.

Regarding the disadvantages of the fibres, based on literature review it can be solved by using chemical treatment. Examples of chemical treatment are alkaline treatment, silane treatment, acetylation treatment, benzoylation treatment, peroxide treatment, maleated coupling agents, sodium chloride treatment, acrylation and acrylonitrile grafting, isocyanate treatment, stearic acid treatment, permanganate treatment, triazine treatment and fatty acid derivate (oleoyl chloride) treatment but in this experiment was been focusing on alkaline treatment using sodium hydroxide (NaOH) as the solution is cheapest and effective among others.

1.2 Objective

The objective of this experiment is to evaluate the effect of the alkalization on mechanical test and physical properties of kenaf fibres reinforced vinyl ester and to investigate the effect of kenaf reinforce vinyl ester in terms of morphological properties.

1.3 Scopes of Study

The composites samples were prepared by using hand lay-up process. Sample then been subjected with fibres loading 5 wt%(Razali, 2016).

The treatment process that emphasize the chemical treatment by using 6% concentration of sodium hydroxide solution to analyze the mechanical and physical properties of the composites. The properties of mechanical and physical properties covered tensile strength, flexural strength, water absorption and moisture content.

The fibres were categorized with two different part which is fibres that were treated and fibres that untreated. The results then been recorded.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In the last few years, the reduction of the petroleum resources have increase the awareness towards the environment and greenhouse effect have given a big impact towards the industries in example automotive, building and nautical and one of method that had been discussed to reduce the effects by replacing the usage of synthetic fibre with the sustainable ones (Krishna and Kanny, 2016). It been stated by (Kabir *et al.*, 2012) which the terrible impact towards the environment decides that the attention from synthetic fibres to renewable/natural fibres.

Natural fibres have been discovered as material in reinforcement agent for more than 3000 years. Based on matrix phase, composites can be classified into three classes which are metal matrix composites (MMCs), ceramic matrix composites (CMCs) and polymer matrix composites (PMCs) (Saba, Paridah and Jawaid, 2015). With development in technology, natural/renewable fibres have been combined with polymer matrix (Razali, Sapuan and Razali, 2018). In (Mohamed *et al.*, 2018) research stated that there are many advantages regarding usage of fibre reinforced polymer (FRP) compared to conventional substances for a certain property. A natural fibre reinforced polymer (FRP) is a composite material that consist of thermoset and thermoplastic resins such as epoxies, polypropylenes, vinyl group and elastomer. (Kabir *et al.*, 2012) said that the introduction of the natural fibre yearly as renewable resources is now popular used as reinforcements in polymer matrix as a result,

(Akil *et al.*, 2011) prove that the demands of natural fibre are fluctuated over the few years for various applications in industrial sectors.

Natural fibre reinforced polymer composites is found to be an alternative way in replacing the petroleum sources that currently are decreasing as it receive attention from manufacturer and scientists as the properties of the natural fibre-based composites are biodegradability, light in weight, nontoxic and directly can prevent the pollution to the environment (Saba, Paridah and Jawaid, 2015). These type of composites presents many advantages compared to synthetic nor to carbon fibres as examples low tool wear, low density, cheaper cost, availability, high strength, high stiffness, good corrosion resistivity and low coefficient friction properties (Razali, Sapuan and Razali, 2018) (Mohamed *et al.*, 2018). Regarding that, natural fibres also have their own limitation as (Maslinda *et al.*, 2017) stated in her research that natural fibres have limit in their application such as variability in quality, high moisture absorption, limited processing temperature and a lesser durability and incompatibility between fibres and polymer matrices.

In a way to overcome the limitation of the natural fibre's properties, many treatments had been endured in a way to improve the performance of the natural fibre itself. In order to improvise the strength of the natural fibre can be achieved by reinforcing it using various chemical treatment on the fibres. (Krishna and Kanny, 2016)

2.1 Natural Fibre

Due to environmental concern, the replacement of using synthetic fibre with natural fibre has been investigated (Maslinda *et al.*, 2017) and in (Krishna and Kanny, 2016) research also been stated that environment was one of the high concern issue and added by financial issue and thus nowadays natural fibres have become interesting and fascinating. Fibres had been stated are look like hair continuous filament materials that act as the

spreading phase (Mohamed *et al.*, 2018) and plant was known as renewable resources, biodegradable and energy that required to produce is small (Akil *et al.*, 2011). Humans have continued to domesticate these crops over time as the natural fibre crops are the earliest fertilized plants. The worldwide now availability in using natural fibres and abundantly agrowaste in engineering research and the search for a sustainable technology in combining polymer science (Mahjoub *et al.*, 2014).

Exterior underfloor paneling of cars, sports equipment and marine structures are example in widely usage of natural fibres composites (Maslinda *et al.,* 2017). The application of natural fibres had been used widely in many sectors of industries such as furniture, construction, automobiles and packing due to its low cost, low weight and less damage as compares to synthetic fibres (Krishna and Kanny, 2016). This two sources above are also been proved in (Mahjoub *et al.,* 2014) research that industry now are focusing in natural fibres as industrial material such as sport equipment, automotive application and construction material for structural and non-structural elements.

There are a few types of fibres that can be obtained which are natural (plant and animal) and man-made (synthetic and regenerated fibres) and can be categorized into three parts which from lignocellulosic materials, animal and mineral (Mohamed *et al.*, 2018). (Akil *et al.,* 2011) also wrote in their journal that natural fibres had been divided into three categories.

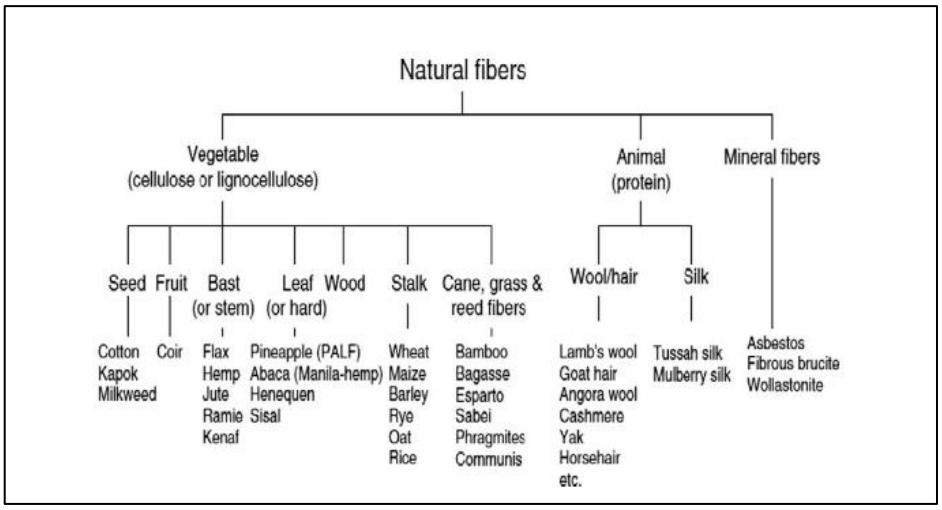

Figure 2.1 Classification of natural fibres (Akil *et al.*, 2011)

Kenaf, roselle, jute, sugar palm, oil palm empty fruit bunch, sisal, pineapple leaf, rice husk, kapok, wood, barley oats choir, and abaca are several types of natural fibres that have been used (Razali, Sapuan and Razali, 2018) while (Akil *et al.*, 2011) claimed that bast fibres such as hemp, jute, flax, kenaf and sisal are most common natural fibres that selected in industries. (Maslinda *et al.*, 2017) reported that the most widely used and studied fibre material are flax, jute, hemp, sisal, ramie and kenaf fibres.

Natural fibres were introduced with intention of yielding lighter composites, coupled with lower costs compared to glass fibre (Mahjoub *et al.*, 2014). One advantage using natural fibres is their low density, which endows them with excellent specific mechanical properties, easier in handling and processing, recyclability and good thermal and acoustic insulation compared to glass fibre (Maslinda *et al.*, 2017). Other advantage that obtained from (Mahjoub *et al.*, 2014) is natural fibre have low density which is (1.2-1.6 g/cm^3) than glass fibre which is (2.4 g/cm^3) as to provide lighter composites. The main reason of consuming the natural fibres in industries because of natural fibres have a lot of advantages can surely save cost in order to get from the suppliers. Natural fibres are consist of 60%-80% cellulose, 5%-20% lignin and moisture up to 20% (Mohamed *et al.*, 2018) and (Oushabi *et al.*, 2017)