EFFECT OF ALKALI TREATMENT ON THE WATER ABSORPTION OF HYBRID PINEAPPLE LEAF/ GLASS FIBRE REINFORCED EPOXY COMPOSITES

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I dedicate this work to:

My wife, Dr. Syahida Suhaimi

&

My parents and family

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ABSTRACT

In this research, the Pineapple Leaf fibre (PALF) have been previously treated with various Sodium Hydroxide (NaOH) concentration percentages in the range between 0% to 10% at 1hour Sodium Hydroxide (NaOH) solution immersion time and dried in oven at 80℃ for 24 hours. The influence of Sodium Hydroxide (NaOH) treatment on Pineapple Leaf fibre (PALF) tensile properties was studied. The result of tensile test on PALF treated showed an improvement in tensile strength with highest value of 43.13MPa of treated Pineapple Leaf fibre (PALF), particularly the treated PALF with 7% Sodium Hydroxide (NaOH) concentration. The 7% treated Pineapple Leaf fibre (PALF) was then selected to use as raw materials for hybrid composites with glass reinforced epoxy matrix. The hybrid composites were subjected to distilled water immersion to study moisture absorption behavior on hybrid composites with four different layer sequences named 4P, PGGP, GPPG and PGPG. The pure Pineapple Leaf fibre (PALF) (4P) have recorded highest percentage for both moisture uptake as well as thickness swelling as compared to the other hybrid composites with value of 12.16% and 51.30% respectively. Hybrid composites are the candidate to be used a pressure vessel especially in oil gas and marine industry that deal with wet and dry environment.

ABSTRAK

Dalam kajian ini, gentian daun nanas (PALF) telah sebelum ini dirawat dengan pelbagai Sodium Hidroksida (NaOH) peratusan kepekatan dalam julat di antara 0% hingga 10% pada 1 jam Sodium Hidroksida (NaOH) Masa penyelesaian rendaman dan dikeringkan di dalam ketuhar pada suhu 80 ° C selama 24 jam. Pengaruh Sodium rawatan Hidroksida (NaOH) ke atas gentian daun nanas (PALF) sifat tegangan telah dikaji. Keputusan ujian tegangan pada PALF dirawat menunjukkan peningkatan dalam kekuatan tegangan dengan nilai tertinggi 43.13MPa dirawat serat daun nanas (PALF), terutamanya PALF yang dirawat dengan 7% kepekatan Sodium Hidroksida (NaOH). 7% dirawat serat daun nanas (PALF) kemudiannya dipilih untuk digunakan sebagai bahan mentah untuk komposit hibrid dengan kaca bertetulang epoksi matriks. Komposit hibrid tertakluk kepada rendaman air suling untuk mengkaji tingkah laku penyerapan kelembapan pada komposit hibrid dengan empat urutan lapisan yang berbeza dinamakan 4P, PGGP, GPPG dan PGPG. gentian tulen Daun Nanas (PALF) (4P) telah mencatatkan peratus tertinggi bagi kedua-dua pengambilan kelembapan serta ketebalan bengkak berbanding komposit hibrid lain dengan masing-masing nilai 12.16% dan 51.30%. komposit hibrid adalah calon yang akan digunakan dalam bekas tekanan terutama dalam industri minyak dan gas laut yang berurusan dengan persekitaran basah dan kering

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CHAPTER 1

INTRODUCTION

1.1 Background

Composite materials are widely implemented in various applications due to their unique properties and characteristics, which cannot be compared to conventional materials such as metals and rubbers. Composites have become an integral part of our day-to-day life and generally used for building, bridges and structures such as boat hulls, swimming pool panels, race car body , spacecraft, asphalt, small boat, and so on. A composite material can be defined as a combination of two or more materials that result in better properties than those of the individuals components used alone. The properties of composites are strongly depending on the strength of reinforcement materials. The most common categories of composites are polymer matrix composites (PMC), metal matrix composites (MMC) and ceramic matrix composites (CMC).

Fibre reinforced plastic (FRP) is a composite materials made of a polymer matrix reinforced with fibre. FRP consists of a polymer matrix implanted with high-strength fibres such as carbon, glass, aramid, basalt and natural fibres. Construction industries give their fully effort to replace metal with fibre-reinforced composite due to their unique properties and characteristics of low weight, low tooling cost, high corrosion resistance and as well as low density.

Natural fibres are usually being used as reinforcing components for thermoplastic and thermoset matrices, because of their special characteristics like

renewably, biodegrability, availability and environmental friendliness that offered by natural fibres. Natural fibres also have unlimited availability, high specific properties, low cost, low density, non-abrasive and less harmful while handling. In Malaysia, the unlimited availability of natural fibres is a benefit for researchers to investigate the properties of the fibre more details Natural fibres come from abandon, renewable, eco-efficient and accessible agriculture and forest feedstock including wood, wood waste, grasses, flax, jute, hemp, cotton and sisal. Natural fibres have potential to be used as a replacement for glass or other traditional reinforcement materials in composites, which are increasingly adopted to replace synthetic polymers in industrial applications.

It is observed that the natural fibre reinforced composites provide better electrical, thermal and acoustic insulation as well as higher resistance to fracture. The mechanical performance of natural fibres is influenced by a different parameter such as the cellulose content, the microfibrillar angle, the fibre diameter, the temperature, the presence of defects and water content inside fibres. Considering the effect of diameter, most studies conducted on natural fibres in traction showed that both the young's modulus and tensile strength increased when the fibre's diameter decreased. Others parameter that gives an obvious effect on mechanical properties of fibres is the contribution of temperature. The excellent mechanical properties of PALF are correlated with its high cellulose content and comparatively low microfibrillar angle.

In recent years, the uses of eco-friendly materials such as pineapple leaf fibre (PALF) have increased tremendously due to unlimited resource from forest and agriculture. Compared to other natural fibers, pineapple leaf fibers (PALF) exhibit superior mechanical properties due to its high cellulose content 70% to 82% and low microfibrillar angle at 4°.

PALF can also be used for multiple industrial purposes. PALF is not suitable for animal feed and after harvest of fruit, the disposal of the leaves becomes a big problem and in year 2008, there is about 400,000 metric tons of abandon waste. Therefore, without any additional cost input, PALF can be obtained for industrial purposes. Within the last 10 years, numerous researchers have studied the potential

and properties of PALF polymer composites.

1.2 Problem Statement

Nowadays, fibre-reinforced polymers (FRP) are widely accepted as replacement for traditional materials because they exhibit good strength by weight ratio, high tensile and flexural strength, high creep resistance and high compact.

Recently, a large amount of interest has been shown in the potential of natural fibres to replace glass fibre in the composites. It is believed that source of petroleum based product are limited and uncertain. So, an alternative with cheap sustainable and easily available raw materials is required. This is a more economical alternative ways and can be very cost-effective than using synthetic fibres. Whilst natural fibre may not be as strong as fibre carbon and aramid, their main advantage is low cost and biodegradability.

In our environment contains a lot of water but its action on composite materials is not fully understood. It is found that the wet conditions cause acceleration to the rate of fatigue cracks growth in glass fibre reinforced plastic under cyclic loading, but decrease the rate of growth under static loading. Water is found to be the greatest enemy to adhesive joints, including those used in hybrid composites.

However, there are problems they with the technical characteristics of reinforced materials that absorb moisture where usually have high moisture absorption and relatively low impact strength. In addition, natural fibres have their drawbacks and this need to be resolved in order to compete with glass. Natural fibres absorb water from the air and direct contact from the environment. This absorption deforms the surface of the composites by swelling and creating voids. The result of these deformations is lower strength and an increase in mass.

An alternative to minimize the problems is the devolvement of hybrid composites which combining natural fibres and synthetics fibres. Synthetic fibre like glass and carbon can improve the stiffness, strength as well as moisture resistant behavior of the composites and hence a balance between environmental impact and performance could be achieved.

Natural fibres reinforced into synthetic fibres are a good example of green composites with is easily degradable by bacteria and enzyme. Another major problem of natural fibres as a reinforced materials improper contact of adherent surface and polymer matrix with bad interaction load transformation from matrix to fibre. Thus to enhance the adhesion property of fibres, it need surface modification by using appreciate chemical like NaOH chemical treatment.

1.3 Objective

The objectives of this research are:

1. To investigate the effect NaOH chemical treatment on mechnical properties of PALF composites
2. To study the moisture absorption characteristics of treated hybridized PALF/Glass epoxy composites

1.4 Scope of Study

The scopes of the research include:

1. Study on Hybrid Composites between PALF and Glass

2. Study on PALF NaOH treatment with different percentage (0, 5, 6, 7, 8 and 10%)
3. Mechanical test on tensile test of dry samples
4. Water Immersion of Hybrid Composites sample in dionized water at 60 ℃

1.5 Significance of Study

Pineapple leaf fibre is very common in tropical regions and very simple to extract fibres from its leaves. The utilization of pineapple leaf fibre in composite material is a new source of materials which can be economic, eco friendly, and recyclable. However, the main issue of PALF is its hydroscopic nature, which makes big hurdle for fibre utilization as a reinforced material in polymer composites. Surface modification of PALF is required to improve for good interfacial adhesion of PALF with polymers in fabrication of polymer composites.

Synthetic fibres can be replaced or partially substituted with PALF in fabrication of composite products for different applications. The author concluded various recent works reported use chemical treatment (NaOH) to increase adhesion of the fibres to the matrix and modify the surface natural fibres.

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