A STUDY ON THE EFFECT OF VARYING FIBER CONTENTS TO THE PHYSICAL AND MOISTURE ABSORPTION CHARACTERISTICS OF HYBRID OIL PALM EMPTY FRUIT BUNCH/KENAF REINFORCED HIGH DENSITY POLYETHYLENE COMPOSITES FOR AUTOMOTIVE APPLICATION

ADEB AHMED SAEED ALDARJI

B041310344

BMCA

Email: adebahmed@outlook.com

Report

Projek Sarjana Muda II

Supervisor: DR. MUHD RIDZUAN MANSOR

Second Examiner: DR. MOHD HAIZAL BIN MOHD HUSIN

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

MAY 2017

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**This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering (Automotive)**

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MAY 2017

DECLARATION

I declare that this project report entitled "A Study On The Effect Of Varying Fiber Contents To The Physical And Moisture Absorption Characteristics Of Hybrid Oil Palm Empty Fruit Bunch/Kenaf Reinforced High Density Polyethylene Composites For Automotive Application" is the result of my own work except as cited in the references.

Signature   :   -----------------------------

Name   :   ADEB AHMED SAEED ALDARJI

Date   :   -----------------------------

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive).

Signature   :   ....

Name of Supervisor :   DR. MUHD RIDZUAN MANSOR

Date   :   ....

DEDICATION

Every time when I need them the most,

They are always by my side.

This humble work of mine I would like to dedicate to

My lovely father,

AHMED SAEED ALDARJI

My lovely and caring mother,

HANAN SALEH BAJNED

My siblings and family,

My supervisor,

DR. MUHD RIDZUAN MANSOR

And

All my friend,

For their assistance & support.

ABSTRACT

Nowadays composites materials have become able to generate high quality, strong and cost-effective products. Therefore, composite materials can be found in several products which are being used in daily life applications. In addition, composites are used in several serious industrials such as aerospace, and military uses. The consumptions of economical agro-based renewable natural lignocellulosic fiber such as empty fruit palm, sisal, coir, and jute etc. in preparing composites with different thermoplastics and thermosetting resins have added much impetus in the latest years. Since Malaysia is the principal producers of palm oil, the profusion of oil palm cellulosic material that can be easily found from the products delivers a new part of attention for research improvement. The potential of utilizing oil palm empty fruit bunch (OPEFB) fibers into natural fiber composites is considering the abundance of the waste in current oil palm industry, especially in Malaysia. By hybridizing OPEFB fibers with stronger and locally available natural fiber resource, in particular kenaf fiber, the performance of the final composites can be enhanced to create higher value of the product with competitive cost. Nevertheless, information on the physical characteristics of the OPEFB/kenaf reinforced high density polyethylene (HDPE) composites is still lacking, especially on the effect of varying fiber contents to the hybrid composites density and water absorption performance. Therefore, the aim of this project is to achieve good combination of properties of hybrid OPEFB and kenaf as filler reinforced in polyethylene composites and to determine the effect of varying fiber contents to density and water absorption property. Physical test according to ASTM D792 were conducted by calculating the mass and the specific density of the samples. In addition, the standard deviation of the samples were calculated related to the mass and specific density. The expected value of the mass standard deviation is 0.07985g which obtains from sample (A). While the expected value of the specific density standard deviation is 0.004176 which obtains from sample (B). Water absorption test according to ASTM D570 were conducted by immersing the five samples in a distilled water bath at room temperature for different time duration. The samples were weighted within 30 seconds and they were immersed again. Same process were repeated to the samples after immersing them for 24, 48, 72, 144, 168, 192, 216 and 240 hours. The percentage of the water in the composites were calculated by weight difference between the samples immersed in water and the dry samples. The result obtained from the water absorption test shows that with increasing the time of immersing the samples in distilled water, the moisture absorption increases.

ACKNOWLEDGEMENT

I would like to express my deepest appreciation to my supervisor Dr. MUHD RIDZUAN MANSOR for giving me this opportunity to do final year project with him. He never hesitated to give me advice and guidance whenever I confronted problems. I am thankful for his patience and advice while leading me in this project.

Secondly, I would like to thank Mr. Muhammad Taufiq bin Jumadi, Graduate Research Assistant from Faculty of Mechanical Engineering, UTeM for spending his time to guide me. He would share his knowledge with me and guide me to do experiment.

I would like to thank my course mates for giving me their support, patience and encouragement. Finally, I would like to thank my family for their support.

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LIST OF ABBREVIATIONS

EFB   Empty Fruit Bunches

PMCs   Polymer Matrix Composites

MMCs   Metal Matrix Composites

CMCs   Ceramic Matrix Composites

CCMCs   Carbon-Carbon Composites

HDPE   High Density Polyethylene

LDPE   Low Density Polyethylene

CPE   Chlorinated Polyethylene

PP   Polypropylene

PS   Normal Polystyrene

PVC   Poly Vinyl Chloride

NFC   Natural Fiber Composites

OPEFB   Oil Palm Empty Fruit Bunch

LIST OF SYMBOLS

ΔM =   Moisture uptake

m_o =   Mass before immersion

m_t =   Mass after immersion

T   =   Temperature

P   =   Pressure

CHAPTER 1

INTRODUCTION

1.1   Overview

In this chapter, a brief introduction of the research background is presented which consists of background information about composites, problem statement, objectives and the scopes of the research.

1.2   Background

Manufacturers, designers, and engineers understand the capability of composites materials to generate high quality, strong and cost-effective products. Composite materials can be found in several of the products which are used today, from the car we drive, to the boats, and RVs which we use on the holidays. In addition, composites are used in several serious industrial such as aerospace and military uses. However, in a marketplace where demands for product enactment are growing, composite materials have confirmed to be effective in dropping costs and improving performance. Campsites explain difficulties, increase performance stages and facilitate the improvement of various innovative products.

The consumptions of economical agro-based renewable natural lignocellulosic fiber such as empty fruit palm, sisal, coir, and jute etc. in preparing composites with different thermoplastics and thermosetting resins have added much impetus in the latest years (Khalid et al. 2006). Wide research has been executed on the agro fiber plastic composites which have been described by a quantity of works (Rowell et al. 1997). This is due to their low density, easy accessibility, nonabrasive natural, and low cost, in addition, their high detailed properties, and biodegradability features. An extensive range of agro-based of fiber is actuality used as the chief fundamental components or as filler agents in these composite materials. Malaysia is the

principal producers of palm oil. The profusion of oil palm cellulosic material that can be easily found from the products delivers a new part of attention for research improvement.

Elaeis Guineensis is the source of oil palm which produces fruits that have big value in a countries like Malaysia and Indonesia. The fruits have been produced from the Elaeis Guineensis have a red color and they can be found in bunches of oil palm tree as shown in figure 1.1. However, 22 kg of palm oil and 1.6 kg of palm kernel oil can be produced from every 100 kg of fruits bunches (Gunawan et al. 2009). Therefore, a large amount of empty fruits bunches will be produced after the fruits have been taken out from bunches as shown in Figure 1.2. Malaysia hold a record of world's supply of palm oil with 47% production while Indonesia with 36% of palm oil volume therefore the empty fruits bunches will be risky to the environment, so those big countries producers need to find environmental solution to make the use of the waste.

Figure 1.1: Fruit Bunch of Oil Palm Tree.

Figure 1.2: Large Amount of the Empty Fiber Bunch.

1.3   Problem Statement

The potential of utilizing oil palm empty fruit bunch (OPEFB) fibers into natural fiber composites is vast considering the abundance of the waste in current oil palm industry, especially in Malaysia. By hybridizing OPEFB fibers with stronger and locally available natural fiber resource, in particular kenaf fiber, the performance of the final composites can be enhanced to create higher value of the product with competitive cost. Nevertheless, information on the physical characteristics of the OPEFB/kenaf reinforced high density polyethylene (HDPE) composites is still lacking, especially on the effect of varying fiber contents to the hybrid composites density and water absorption performance. Therefore, this project is conducted to find out the effect of varying fiber contents to the density and moisture absorption of the final OPEFB/kenaf reinforced HDPE composites. Based on the literature review, water absorption affect the physical properties of hybrid OPEFB/kenaf reinforced HDPE composites.

1.4   Objective

The objectives of this project are as follows:

I.   To determine the effect of varying fiber contents to the density property of hybrid oil palm empty fruit bunch/kenaf reinforced high density polyethylene composites.

II.   To determine the effect of varying fiber contents to the water absorption property of hybrid oil palm empty fruit bunch/kenaf reinforced high density polyethylene (HDPE) composites.

1.5   Scope of Project

The scopes of this project are:

I. To formulate hybrid OPEFB/kenaf bio-composite are 40 wt. % natural fibres and 60 wt. % high density polyethylene (HDPE).
II. To formulate hybrid OPEFB/kenaf bio-composite at varying OPEFB to kenaf (OPEFB: Kenaf) fiber wt% ratio, which are 100:0, 75:25, 50:50, 25:75, and 0.100.
III. To perform density evaluation based on ASTM D792.
IV. To perform water absorption test based on ASTM D570 by immersing the sample in distilled water bath room temperature for different time durations.

CHAPTER 2

LITERATURE REVIEW

2.1   Overview

This chapter will discuss the literature review related to the introduction of the composites, Also, the types of composites and constituents of the composites will be discussed in details. However, there are several types of manufacturing process that use to prepare the samples while some of these types will be discussed. Classification and performance in term of mechanical properties of natural fibers will be discussed in this chapter as well.

2.2   Introduction

Composites are materials that include tough weight conveying object (A.K.A reinforcement) inserted in very weak material (A.K.A matrix). Reinforcement supplies force and stiffness which help to carry and support constructional weight. The matrix, saves the location of the reinforcement. Expressively, composite's elements hold their individual, chemical and physical properties; yet together they manufacture a group of quality which singular elements would not be able of manufacturing along (Hull and Clyne 1996).

2.3   Types of Composites

For effortlessness, composites can be assembled into classes in view of the regular of the grid every sort has (Drzal, 2000). The ways of manufacture also shows difference according to chemical and physical proprieties of the matrices and reinforcing fibers.

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2.3.1   Polymer Matrix Composites (PMCs)

Polymeric is the most regularly utilized matrix materials. The explanation behind this are two crease. All in all the mechanical belongings of polymers are lacking for some basic goal. To be exact their best quality and inflexibility are low contrasted with to material which are metals and ceramics (Jin, Xia, & Gerhardt, 2016). These challenges are solve and get rid of these challenges by reinforcing to dissimilar materials with polymers. Furthermore the handlings of polymer network composites require exclude every high pressure and do not necessitate other high temperature. Likewise types of gear needed for assembling polymer grid complexes are always less complex. Consequently polymer grid composites grew faster and quicker as soon got to be famous for auxiliary applications. Composites are utilized in light of the fact that common properties of the composites are way preferable than those of the individual and entity segments for instance polymer/ceramic. Composites have a more noteworthy modulus than the polymer part yet are not as fragile as pottery.

2.3.2   Metal Matrix Composites (MMCs)

MMCs have various purposes and reasons of interest above strong metals like larger and higher specific modulus, higher specific quality, the enhanced properties at raised temperatures, and very low coefficient of warm enhancement (Simar & Aude, 2016). By virtue of these perfect qualities metal system composites are less and below thought for broad assortment of applications viz. consuming chamber gush (in rocket, space carry), lodgings, through tube, links, warm exchangers, auxiliary individuals and so on.

2.3.3   Ceramic Matrix Composites (CMCs)

Ceramic materials have great quality and modulus at lifted temperatures. In any case, their utilization as structural components is extremely constrained due to their fragility. The ceaseless fiber-fortified ceramic-matrix composites (CMCs), by fusing fibers in ceramic matrices to enhance the sturdiness, in any case, abuse their alluring high-temperature quality as well as decrease the inclination for disastrous disappointment. These materials have as of now been actualized on some air motors' parts (Li Longbiao,2016).

2.3.4   Carbon-Carbon Composites (CCMCs)

Carbon-carbon composites have been connected in aeronautics and aviation fields for their unrivaled warm and high temperature mechanical properties, for example, high warm conductivity, low thickness, high particular quality, fantastic substance and removal resistance (Kou et al. 2017).

2.4   Constituents of Composites

2.4.1   Matrices

The concerned when the exchange could happen between the fibers to give an obstruction against an unfriendly atmosphere and to shield and protect the outside area of the fibers from any other mechanical scraped area is the part of grid in fiber-reinforced composites. The matrix accepts and enables an important and key part in the tensile load passing on limit and within boundary of a composite construction. The coupling specialist or matrix in the combined and composite is of its essential significance. There are exactly four noteworthy sorts

of matrices, which actually have been accounted for: Metallic, Ceramic, Carbon and Polymeric. A large portion of the composites used as an important piece of the industry now days depend on polymer matrices. Polymer pitches have been accordingly separated broadly and divided into two types:

a)   Thermosetting

Thermoset is a hard and hardened material and fabric that never mellow or easily can be flexible when it is heated (Hussien, Abass, & Abass, 2010). Thermosets are hardened and never extend like elastomers and thermoplastics do.

b)   Thermoplastics

Thermoplastics are polymers, which it always needs hotness to allow them to be processable (Hassan et al. 2010). Then, following the last step is to cooling, materials hold their form and the shape have been resulted. Furthermore, these polymers possibly might be also warmed and transformed as well, frequently without noticeable and huge changes in their form and properties. The thermoplastics that have been operated as matrix for usual fiber reinforced composites are meant to be with high density polyethylene (HDPE), low density polyethylene (LDPE), chlorinated polyethylene (CPE), polypropylene (PP), normal polystyrene (PS), poly vinyl chloride (PVC), mixtures of polymers and recycled thermoplastics.

2.4.2   Reinforcing Fibers

2.4.2.1 Synthetic Fibers

The best major categories of synthetic fibers contain fiberglass, carbon, Aramid/ Kevlar fibers and boron fibers.

I.   Carbon Fibers

Carbon fibers are mostly used for reinforcing a very specific lattice materials to make a form composites (Rezaei, Yunus, & Ibrahim, 2009). Carbon fibers are often unidirectional reinforcements and it can be arranged and in order for such a method in the composite, which is further to be grounded in the heading that it absolutely has to be bear loads. The physical properties of carbon fiber reinforced composite materials considered based on drastically on matrix's technique, putting the fiber in order , the amount and number part of the fiber and matrix, and based on the circumstances of the embellishment . Minimum types and kinds of matrix materials e.g., glass and ceramics, metal and plastics are always have to be well arranged as matrices for reinforcement by carbon fiber. Carbon fiber composites, to be exact those with polymer matrices, have transferred into the predominant forced and to push the composite materials for aviation, car, wearing merchandise and different applications, thus their high and perfect quality, well designed and high modulus, low density, and reasonable price for such and application needed to resist high temperature as on description of spacecraft's.

II.   Glass Fibers

Glass filaments are generally known as very familiar of all reinforcing fibers for polymeric (plastic) matrix composites (PMCs). The most important and informatics points of interest as the key of success of glass fiber are priced low, high tensile strength, ability to resist high chemical and astounding protecting properties. The two common types of glass fibers commonly arranged as an element of the fiber reinforced plastics businesses are E-glass and S-glass. The other type is market known as of C-glass arranged as well as a part of chemical applications, which also needs consume extra prominent imperviousness to acids than the amount it gives by E-glass.