TO STUDY THE EFFECT OF DIFFERENT PROCESS ON THE MECHANICAL AND PHYSICAL PROPERTIES OF THE COCONUT COIR FIBER REINFORCED LDPE COMPOSITE

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) with Honours. The member of the supervisory committee is as follow:

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…….

ABSTRACT

This research aims to study and analyze the effect of different process on the mechanical and physical properties of the coconut coir fiber reinforced LDPE composite. The main raw materials used in this project are Low Density Polyethylene (LDPE) resin as the matrix materials and coconut coir fiber as the reinforcement material for the composite fabrication. The composite was fabricated by using two processes which are extrusion molding and compression molding. The composite from both of the process were analyzed in terms of mechanical and physical properties. The composite specimens were cut into the specific dimension according to the American Society for Testing and Material (ASTM) standard for testing process. The specimens were primarily tested for the mechanical properties analyze which is Tensile Test. The proportions of the composite compounding in both processes were used at the variety weight percentage, wt % of 92, 87,82wt% LDPE as the matrix material and 5, 10, 15 wt% coconut coir fibers as the reinforcement. The composite specimens were also conducted with water absorption test in order to investigate physical properties reaction of the coconut coir fiber reinforced LDPE composites. The microstructures of the fabricated composites were observed under the Digital Microscope to understand the fracture behavior, the fiber distribution and the surface morphological. The introduction of 3wt% of Maleic anhydride-grafted polyethylene (MAH-g-LDPE) was done. It used to the best formulated composites which indicate the improvement of the interfacial adhesion between the fiber-matrix interphase through the morphology observation.

ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji dan menganalisis kesan proses yang berbeza ke atas sifat mekanik dan sifat fizikal serat sabut kelapa menguatkan LDPE komposit. Bahan asas utama yang digunakan dalam projek ini adalah Polyethylene (LDPE) resin sebagai bahan matriks dan serat sabut kelapa sebagai bahan penguatan fabrikasi komposit. Komposit akan dibentuk dengan menggunakan dua proses iaitu proses penyemperitan dan proses pemampatan. Kepingan komposit daripada kedua-dua proses tersebut dianalisis dari aspek sifat mekanik dan fizikal. Kepingan komposit dipotong mengikut spesifikasi tertentu berdasarkan piawaian ujian American Society for Testing and Material (ASTM). Pada permulaannya, specimen-spesimen diuji pada Analisa Sifat Kritikal iaitu ujian tegangan. Formula sebatian terbaik komposit digunakan secara seragam pada peratusan berat (wt%) dengan 92, 87,82 wt% LDPE sebagai bahan matriks dan 5,10, 15 wt% serat sabut kelapa sebagai penguat. Pengujian spesimen komposit juga dilakukan dengan uji penyerapan air untuk menyiasat reaksi dalam sifat-sifat fizikal LDPE / komposit serat sabut kelapa. Struktur mikro daripada spesimen yang diuji dilakukan dengan menggunakan Digital Microscope untuk memahami perilaku , serat edaran, dan morfologi permukaan. Pengenalan 3wt% daripada Maleat anhidrida-polietilena (MAH-g-LDPE) telah dilakukan. Ini digunakan sebagai rumusan terbaik komposit yang menunjukkan peningkatan pengikatan antara muka antara gentian-matriks melalui mengamati morfologi.

DEDICATION

I would like to dedicate this report for my beloved family and friends.
I am what I am because of them…

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Nowadays, technology of plastic is widely used especially in manufacturing industries such as Malaysia. Plastic is the general common term for a wide range of synthetic or semisynthetic organic amorphous solid materials suitable for the manufacture of industrial products. Plastics are typically polymers of high molecular weight, and may contain other substances to improve performance and/or reduce costs (Kalpakjian and Schmid, 2006). There are many new materials with enhanced properties are also developed to cater for the increasing design requirement of the new age engineering usage and applications.

The word plastics were first known to be used around the 1909's and commonly is employed as a synonym for polymer. Plastic are one of numerous polymeric materials and have extremely large molecules. Consumers and industrial products made of polymers include food and beverage containers, packaging, signs, housewares, housing for computers and monitor, textiles, medical devices, foams, safety shields, toys, appliances, lenses, gears, electronic and electrical product, and automobile bodies and component (Kalpakjian and Schmid , 2006). These substitutions reflect the advantages of polymer in terms of the following characteristics such as corrosion resistance and resistance to chemicals, low electrical and thermal conductivity, low density, high strength-to-weight ratio particularly when reinforced, noise reduction, wide choice of colors and transparencies, ease of manufacturing and complexity of design possibilities and relatively low cost.

Plastic can be formed, machined, cast, and joint into various shapes with relative ease. Plastic are available commercially as film, sheet, plate, rods, and tubing of various cross sections. Two major classes of polymers are thermoplastics and thermosets. Thermoplastics become soft and easy to form at elevated temperature; they return to their original properties when cooled. Their mechanical behavior can be characterized by various spring and damping models. Their behavior includes such phenomena as creep and stress relaxation, crazing and water absorption. Thermosets which are obtained by cross-linking polymer chains and can not become soft to any significant extent with increasing temperature. They are much more rigid and harder than thermoplastics and they offer many fewer choices of color.

In additional to the type and quality of the material used, important factors in the structure of composite materials are the size and length of the fiber, their volume percentage compared with that of the matrix, the strength of the bond at the fiber-matrix interface, and the orientation of the fibers in the matrix. Reinforced plastics typically are used in commercial and military aircraft, rocket component, helicopter blades, automobile bodies, leaf springs, drive shafts, pipes, pressure vessels, sporting goods, helmets, other structures and components. Glass or carbon fiber-reinforced hybrid plastics are available for high-temperature applications with continuous use ranging up to about 300°C. The processing of reinforced plastics can present significant challenges. As a result, several innovative techniques have been developed for manufacturing both large and small parts, particularly by molding, forming, cutting and assembly (Kalpakjian and Schmid, 2006).

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1.2 Background of the Project

Plastic mixture technology is a very famous technique among the manufacturer in plastic industry to make new material that can improve the mechanical properties to support and solve the problems such as replacing the material that higher cost in production. This technique needs more experiments and studies because to setup a new material, a suitable parameter setting of a machine should be determine. However in this specific project, the additive (natural fibre) are added to the original material polyethylene (LDPE) and the machine parameter will adjust to its new content accordingly, further experiments have to be done to establish the parameter of this machine. This research will use two machines extrusion molding and compression molding and define which is the best process used in producing the product in terms of the best quality in mechanical properties by using the LDPE/coconut coir fiber reinforce composite.

Natural fibres have played a major role throughout human history. Even the earliest humans learned to use these resources to make shelters, cook food, construct tools, make clothing, paper, and produce weapons. Collectively, society learned very early the great advantages of a resource that was widely distributed, multi functional, strong, easy to work with, aesthetic, biodegradable, and renewable. Compared to synthetic fibres made from glass, carbon and steel, natural fibres have a high aspect ratio, high strength to weight ratio, relatively low in energy conversion, and have good insulation properties (sound and thermal) (Paridah, 2008). International research has demonstrated the technical feasibility of manufacturing eco-friendly composites based on biodegradable polymers, either natural or synthetic in combination with local wood or plant fibre resources. Although the polymers remain expensive relative to commodity plastics, perhaps presently three to five times or more the cost of resins such as PP, LDPE, HDPE and PVC, the incorporation of natural fibres provides a potential means of reducing total material cost while at the same time improving the material mechanical properties (Ray Smith, 2008).

The properties of polymers depend on the molecular weight, the structure (linear, branched, cross linked, or network), the degrees of polymerization and crystallinity, and on the additives. Additives have such functions as improving strength, flame retardation, lubrication, imparting flexibility and color, and providing stability against ultraviolet radiation and oxygen. Polymer structures can be modified by several means to impart a wide range of desirable properties to plastics.

Composite materials are an important class of engineered material with numerous attractive properties. A composite material is a combination of two or more chemically distinct and insoluble phases with a recognizable interface, in such a manner that its properties and structural performance are superior to those of the constituents acting independently. Three major categories are fiber-reinforced plastics, metal-matrix composites, and ceramic-matrix composites. Fiber reinforcements significantly improve the strength, stiffness, and creep resistance of plastic with particularly their strength-to-weight and stiffness-to-weight ratios. Composite materials has found increasingly wider applications in aircraft, space vehicles, offshore structures, piping, electronics, automobiles, boats, and sporting goods.

This research touches more on the composite product which consists of combining two or more constituents or material that is different from the common heterogeneous material. This researches represent about the combination between natural fibres (coconut coir) reinforced with the low density polyethylene (LDPE) thermoplastic material. A composite is considered to be any multiphase material that exhibits a significant proportion of the properties of both constituent phases such that better combination of properties is realized. Composites may be selected to give unusual combination of stiffness, strength, light weight, high temperature performance, corrosion resistance hardness, conductivity or cost effectiveness (Callister, 2006).

1.3 Problem Statement

Sanadi *et al*., (1995) state that the low processing temperature permissible to the lingo-cellulosic fiber in thermoplastics is limited due to fiber degradation at higher processing temperatures. It is important to ensure the degradation of the coconut fiber will lead to control temperature processing or otherwise it will lead to the failure or poor performance of the fabricated composite properties. Therefore, the chosen suitable processing setting in terms of classifying the temperature is an important consideration for the fabrication of the coconut coir fiber reinforced LDPE composite. The standard condition of these composite will determined whether these material is suitable to use in extrusion molding or compression molding without causing problem to the machine and affecting to the mechanical properties. In a study on recycling of polyethylene material by S. Koseva, (2002), all result based on the experiment indicate that some degradation reactions (branching/cross-linking) occurred during processing/reprocessing. These cause structural changes into the polymer chains, which affect physical and thermal but mostly of mechanical properties. In this study, the research is conducted with the difference single processing in order to observe the effect on the mechanical and physical properties of LDPE/coconut coir composite.

Plastic material, both reinforced and none reinforced are potentially well to satisfy these new requirement such as fiber reinforced plastic and polymer-matrix composite, but the cost and performance of plastic component depend on the material, properties, strength and process involved. LDPE is an option to take as the research material which is their properties are quite low compared to others material and suitable for improvement in terms of high tensile strength, hardness, toughness, lightweight, easily fabricated and etc. The advantage of LDPE is low density, cost quite high compare to PP, HDPE, and PVC. Zampaloni *et.al* (2007), stated that the increasing of fiber loading will decrease the usage of matrix. Thus, less of matrix used in composite tends to save cost in mass production of composites. Natural fiber is an option because of its material low cost, material easy to fabricated and good properties. The uses of natural plant fibers as a reinforcement materials to replace synthetic fibers is receiving great attention, due to the

advantages of the renewability, low density and high specific strength (Ochi *et al*., 2008). Thus, the introduction of natural fiber such as coconut coir, kenaf, hemp, ramie, and flex has attractively influenced the production of biodegradable materials lately, especially in manufacturing industry (Bledski *et al*., 2002). Natural fiber like coconut coir can be used as replacement to the conventional fiber. The mixture between LDPE with coconut coir is the new material where natural fiber is mix with thermoplastic to improve the mechanical properties in terms of hardness, toughness and stiffness. Specifically, the good properties of coconut coir is suitable to use in the project because it lightweight, corrosion resistance, low to moderate cost, high thermal stability, has easy material ability process and make them as a reinforcement of choice by industry.

1.4 Objectives of the project

The main purposes of this project:

1 To produce a well mixed LDPE/coconut coir fiber by using an Extrusion Molding machine and a Compression Molding machine.

2 To access the effect of mechanical properties and physical properties of the fiber reinforced polyethylene (LDPE) composite by using difference process; extrusion process and hot press process.

3 To observe the best process of mixture LDPE/coconut coir composite in terms of the mechanical properties and physical properties characteristic.

1.5 Scope

The study was started by preparing and characterizing the coconut coir fiber as raw material to be used as reinforcement material in the fabrication of the coconut coir fiber reinforced LDPE composite. The materials used that related in this study are polyethylene (LDPE) pellets and coconut coir fiber. The study was conducted within the internal mixture single screw extrusion moulding machine, injection molding machine,

crusher machine and compression molding machine. The coconut coir short fibers were prepared by using the crusher machine to get the various size of fiber length. The size and density of the fiber reinforced were determined by using Digital Microscope and Electronic Densimeter model MD300-S, respectively.

In line with the objective of this study, both of the matrix and reinforcement were loaded into the hopper for mixing process in the internal mixture extrusion molding. Extrusion molding HAAKE model Rheomix OS (Thermo Electron Corporation, Germany) machine were used to well mix 5 wt%, 10wt% and 15wt% fiber loading into the mixture of composites. The effect of fiber loading for coconut coir fiber on polyethylene composite was investigated by standardizing the weight percentage (wt%). The increasing weight percentage (wt%) of the fiber is expected to increase the mechanical properties. The fabrication process involves is the hot press or compression molding process and single screw extrusion molding process. The minimum and maximum temperature was used are 130ºC and 180 ºC.

The effect of the mixer variety weight percentage of the matrix and reinforcement were examined and analyzed by using tensile test for analyse the mechanical properties and for analyse the physical properties will using water absorption test. The testing process was conducted with four set for each type testing.

The Microstructure analysis for the fracture surface and composition of the fabricated composites will be observed by using the Digital Microscope in order to relate the morphological surface due to behaviour of the mechanical properties of the composites and to observe the composition compounding of the LDPE/coconut coir composite.