UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF BIODEGRADABLE PLASTIC WITH NATURAL SOURCES AS PACKAGING MATERIAL

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Manufacturing Engineering Technology (Process and Technology) with Honours

by

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Signature :
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APPROVAL

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

_____

(Mohammad Khalid Bin Wahid)

ABSTRAK

Biodegradable plastik adalah plastik selain kepada plastik sedia ada. Ia adalah satu inisiatif baru untuk mewujudkan sebuah dunia yang akan menjadi mesra alam dan dalam usaha mempelbagaikan sumber altenatif. Biodegradable plastik atau plastik berasaskan bahan organik adalah satu bentuk plastik yang diperolehi daripada sumber-sumber biojisim yang boleh diperbaharui, seperti minyak sayuran atau kanji. Manakala plastik konvensional berasal dari petroleum. Plastik mesra alam menggabungkan ciri-ciri plastik dengan keupayaan sepenuhnya lupus. Tujuan utama penyelidikan ini adalah untuk membuat bungkusan plastik mesra alam untuk industri makanan. Biodegradable plastik dihasilkan daripada kanji ubi kayu dan diperkukuhan dengan gentian semulajadi sebagai pengganti plastik sedia ada. kanji ubi kayu digunakan sebagai bahan utama dan gentian tebu dan gentian kelapa sawit di kaji dalam projek ini. Kaedah yang terlibat dalam projek ini dibahagikan kepada empat peringkat utama iaitu campuran bahan asas, proses pemanasan, proses pembentukkan dan proses pengeringan. Keberkesanan bioplastik dinilai dengan analisis ujian melalui ujian tegangan dan ujian pelupusan. Hasilnya akan menunjukkan bioplastik meningkatkan sifat-sifat fizikal dan mekanikal, dengan cara melindungi barangan dan bahan kimia, memanjangkan hayat simpanan bahan makanan, boleh juga menjadi baja dan kawalan kimia apabila dilupuskan dan boleh dilupuskan dalam yang cara mesra alam.

ABSTRACT

Biodegradable plastics are plastics in addition to the existing plastic. It is a new initiative to create a world that will be environmentally friendly and in the diversification of alternative sources. Biodegradable plastic or plastic-based organic matter is a form of plastics derived from sources of renewable biomass, such as vegetable oil or starch. Whereas conventional plastics derived from petroleum. Biodegradable plastic combines the features of the full capabilities of plastic to disposed. The main purpose of this research is to make biodegradable plastic packaging for the food industry. Biodegradable plastics produced from cassava starch and reinforced with natural fibers as a substitute existing plastic. tapioca starch is used as the main ingredient and sugar cane fiber and oil palm fiber studied in this project. The methods involved in the project is divided into four main stages which are material mixing process, the heating process, the process of forming and drying process. The effectiveness of the biodegradable plastic is evaluated with the testing analysis tensile testing and biodegradable test. The results will show biodegradable plastic improve the physical and mechanical properties, by protecting goods and chemicals, prolonging the shelf life of food, can also be steel and chemical control when disposed of and can be disposed of in an environmentally friendly way.

DEDICATION

This final year report is dedicated to my parents my beloved father Othman Bin Ishak and to the loving of my mother Siti Aishah Binti Din. For their endless love, support and encouragement. And who introduced me to the joy of reading from birth, enabling such a study to take place today. You have successfully made me the person I am becoming you will always be remembered

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I would like to take this opportunity to express my appreciation to my supervisor, Mohammad Khalid bin Wahid for his kindness, advice and guidance to help me accomplish this project from day one and beyond. I cannot pay back for all his contributions were definitely helped me a lot in this project.

I would also like to thank all partners for their significant advice and help and also for my beloved one, who always supported me throughout this project and for helping me get through it. Just calm can repay all the kindness you all. Furthermore, I also thank my parents Othman Bin Ishak and Siti Aishah Binti Din which helped a lot in terms of finance, advice and encouragement.

Finally, I would like to thank to any other individual or group that I no longer had also played an important role in doing my final year project and report. I hope that the report of this final year project will meet the requirements as requested in the format. Thanks.

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UTS	-	Ultimate tensile strength
MMC	-	Metal matrix composite
CMC	-	Ceramic matrix composite
PMC	-	Polymer matrix composite
NFRP	-	Natural fiber reinforced polymer
mm	-	Millimetre
µm	-	Micrometre
Mpa	-	Mega Pascal
KJ	-	Kilo Joule
^{o}C	-	Celsius
VARI	-	Vacuum assisted resin infusion
CM	-	Compression molding
ASTM	-	American Society for Testing and Materials
PH	-	Potential Hydrogen
PP	-	Polypropylene
PCL/TPS	-	Polycaprolactone/Thermoplastic Starch Blend
RM	-	Malaysian Ringgit
SD	-	Standard Deviations
SME	-	Small Medium Enterprise

CHAPTER 1
INTRODUCTION

1.1 Project background

Biodegradable plastic more particularly that of the polymer obtained from sources that are renewable. The biodegradable polymers have been largely used in several applications such as the food industry. However, this polymer does not have broad applications in the packaging sector industry to replace oil-based plastic materials, although it can be an attractive way to eliminate the limitations of petroleum resources when the time comes. Fossil fuels and gas can be partially replaced by green agricultural resources, which should take part in the reduction of carbon dioxide emissions. Biodegradable plastics can be the basis for a more environmental friendly and sustainable alternative to current materials based solely on petroleum. Bio-based materials offer value in the equation of sustainability and life cycle to be part of the cycle that is not contaminated.

Bio polymers are generally able to be used safely for disposal in an effective manner and ecology through the disposal of compost and biological waste water treatment. The use of a single, short-lived and disposable products can be a challenge in engineering to become bio-based products and environmentally friendly. Polymer materials has been developed in the past and has been widely accepted that the use of durable polymer for long lasting applications such as packaging, catering, surgery and hygiene, are not fully adequate. Most synthetic polymers are derived from petroleum and take a long time for disposal.

Now days, plastic containers are successful replacing glass, tin, metal, aluminum, paper and etc. Therefore, the advantage of plastic are light and less bulky than other packaging materials that could be processed into any desired shape or form into films, sheets and plates.

Biodegradable plastic are plastics that are made from organic sources and are not the same as conventional plastics where petroleum-based. Organic materials such as vegetable oil, cellulose, acid, alcohol and starch goes through several processes before becoming biodegradable plastic. Biodegradable plastic are far more environmentally friendly than plastic that is because its contents. Therefore biodegradable plastic is more suitable as packaging material. The packaging is made from biodegradable plastic will give reaction to the situation it.

1.2 Problem statement

Due to the increased use of various petroleum base plastics derived plastic, paper and combination packaging materials Plastic is found to be the best because of the characteristics of long life with it and uses is increasing every day. However, the plastic difficult be degraded by natural processes within a short time and left as plastic waste also causing environmental problems. The method used to destroy other types of waste such as burning and destruction of the plant is not suitable for plastic. In response to the problems associated with plastic waste. Production of biodegradable plastics have attracted considerable interest. In this work biodegradable plastic starch produced by combining organic and biodegradable polymers. Plastics produced have different biodegradability. The process and method to transform the composite material become a product should be explained to become the green industries expands more rapidly in the future.

1.3 Objective

Two objectives need to be achieved. These are as follows:

1) To develop biodegradable plastic from natural organic composite. Which are matrix from nature and nature fibers combined as reinforcement. This combined will become the composite material

2) To determine the process and method used to transform the organic composite become a biodegradable plastic as packaging material and the composite will test on mechanical test.

1.4 Scope

There are will be three scopes carry out in this experiment and below are the scope:

1) This project will deal with a process to develop biodegradable plastic base on the organic sources which is starches and fibers.

2) The composite will transform biodegradable plastic as packaging product with appropriate methods.

3) The composite material will run process simulation test ultimate tensile test (UTS) and the result will carried with the finish product.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter review related studies done by previous researcher on the bio degradable plastic by using natural sources to change the user of commodity plastic product to biodegradable plastic product. Through this chapter, the study on the existing commodity plastic, the natural sources can transform to composite material and the reinforcement from fiber natural. The literature review mainly focused on the various types of process plastic transforms and the equipment related. Engineering properties and related experimental are focused on tensile strength properties will be studied and discussed.

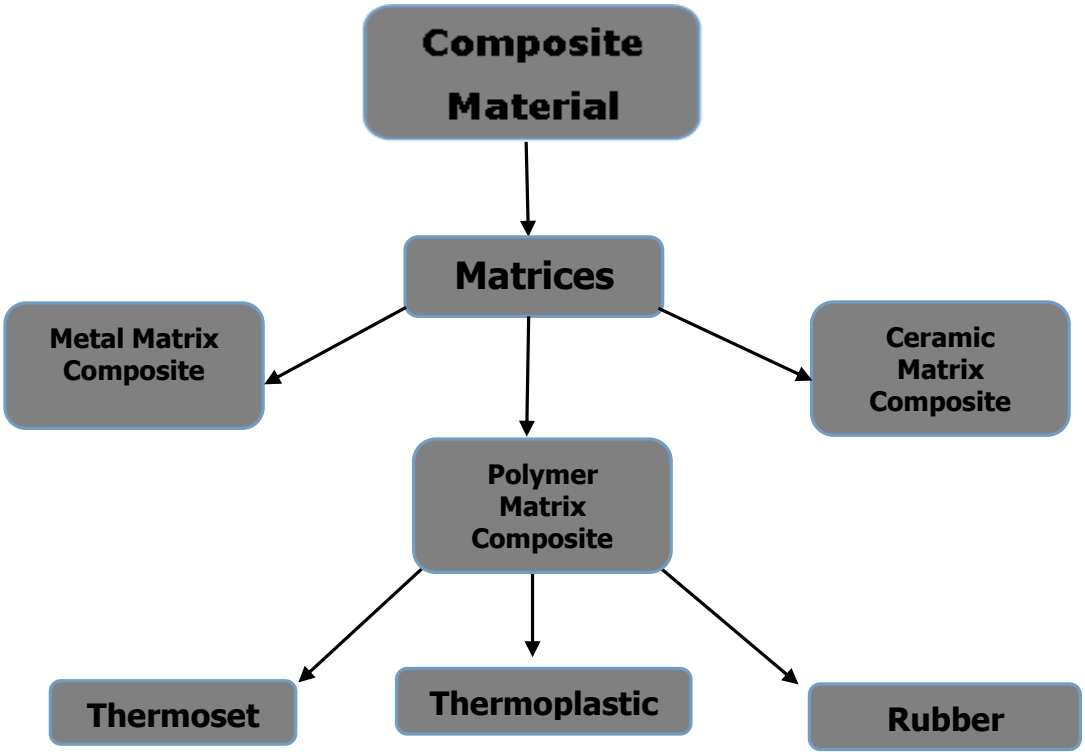
2.2 Polymer composite

Composites can be defined as materials that consist of two or more chemically and physically different phases separated by a distinct interface. The different systems are combined to achieve a system with more useful structural or functional properties non attainable by any of the constituent alone (Mao et al., 2015). Composites, the wonder materials are becoming an essential part of today materials due to the advantages such as low weight, corrosion resistance, high fatigue strength, and faster assembly. The basic difference between blends and composites is that the matrix and reinforce in the

composites remain recognizable while these may not be recognizable in blends (Oliveux et al., 2015)

The daily useful materials used in life are wood, concrete, ceramics, and plastic. The most important polymer composites are found in nature and these are known as natural composites. The connective tissues in mammals belong to the most advanced polymer composites known where the fibrous protein, collagen is the reinforcement (Liu et al., 2014) That are extensively used as materials in making aircraft structures, electronic packaging to medical equipment, space vehicle and home building (Mousa and Kim, 2015) .It functions both as soft and hard connective tissue Composites in structural applications have the following characteristics. They generally consist of two or more physically distinct and mechanically separable materials. That are made by mixing the separate materials in such a way as to achieve controlled and uniform dispersion and have superior mechanical properties and in some cases uniquely different from the properties of their

On the basis of matrix phase, composites can be classified into metal matrix composites (MMC), ceramic matrix composites (CMC), and polymer matrix composites (PMC) (Chandramohan and Marimuthu, 2011)



2.2.1 Polymer matrix composites (PMC)

PMC are very popular due to their low cost and simple fabrication methods. Use of non-reinforced polymers as structure materials is limited by low level of their mechanical properties, namely strength, modulus, and impact resistance. Reinforcement of polymers by strong fibrous network permits fabrication of PMC (Joseph et al., 2012). The shape of the reinforcing particles can be spherical, cubic, platelet, regular or irregular geometry. Particulate reinforcements have dimensions that are approximately equal in all directions. Polymer matrix composites are often named by the type of their reinforced fiber, such as glass fiber composite material, carbon fiber composites, and hybrid fiber composite (Ru-Min Wang et al., 2011).

These include not only the types of matrix and reinforcement but also their relative proportions, the geometry of the reinforcement, and the nature of the inter-phase. PMC are strongest when stressed parallel to the direction of the fibers and weakest when stressed perpendicular to the fibers. In practice, most structures are subjected to complex loads, necessitating the use of fibers oriented in several directions (Zare, 2016).When discontinuous fibers or particles are used for reinforcement, the properties tend to be more isotropic because these reinforcements tend to be randomly oriented, Such PMC lack the outstanding strength of continuous fiber PMC, but they can be produced more low capital cost, high energy efficiency, ease of processing, simple process equipment and relative ease to operate using the technologies developed for unreinforced plastics, such as extrusion, injection molding, and compression molding (Wang et al., 2015)

Toughness is such a property. In metals, wherein the dynamics of crack propagation and failure are relatively well understood, toughness can be defined relatively easily. In an advanced composite. However, toughness is a complicated function of the matrix, fiber, and inter-phase, as well as the reinforcement geometry (Catalanotti and Xavier, 2015). Shear and compression properties of advanced composites are also poorly defined. Another result of the complexity of PMC is that the mechanical properties are highly interdependent. For instance, cracking associated with shear stresses may result in a loss of stiffness. Impact damage can seriously reduce the

compressive strength of PMC (Lewandowski et al., 2016). Compressive and shear properties can be seen to relate strongly to the toughness of the matrix, and to the strength of the interfacial bond between matrix and fiber.

2.3 Conventional plastic polymer

From Chemical Heritage Foundation a conventional plastic is a plastic made from petroleum sources. Plastic packaging creates unnecessary waste and plastic use in food storage and cooking can carry out health risks when chemical reaction from response to environmental condition that can effect substantially (Fallis, 2013). The conventional plastic or commodity plastic have a labels which are one until seven. The labels is used primary on disposal plastic packaging and single use containers. Non-disposal food use goods such as dinnerware, pitchers, flatware and permanent bottle is not show the labels. Below describes the distinctive characteristics of each type of plastic, the product are used and cycle time of plastic.

1 **PET** **(**(Polyethylene Terephthalate)	This is the easier plastic to recycle. Add to it that these materials are relatively cheap and you have the perfect container for water bottles, clam shell packaging, plastic cup, produce bags and several other container packaging. Actual breakdown time for this type of plastic under perfect conditions can range from 5 to 10 years (Fallis, 2013).
2 **HDPE** (High density Polyethylene)	This is probably the most recognized recyclable plastic and is used to make detergent bottles, bleach bottles, milk cartons, shampoo and conditioner bottles, motor oil and many other non-food items. These plastics will degrade in just under 100 years depending on the thickness of the plastic used (Society and Industry, 1988).
3 **PVC** (Polyvinyl Chloride)	PVC can be found in a number of items from pipes to children toys. PVC does not readily degrade and when it does it gives off a number of toxic

	materials. This is the single worst plastic according to several health organizations (NAPCOR, 2010).
4 **LDPE** (Low-density Polyethylene)	This is what current plastic grocery bags are made. If exposed to ultra violet light, these bags have been estimated to break down in as little as 500 years with a conservative average time of 1000 years (Ldpe et al., 2003).
5 **PP** (Poly propylene)	This material is generally found in more permanent capacities such as rope, clothing and performed shower kits. It is highly resistant to photo degradation and will not decay for millennia (Crighton, 2008).
6 **PS** (Polystyrene)	This is the plastic in Styrofoam packaging peanuts, cups, coolers and many other lightweight applications. This type of plastic will break down in under 50 years (Go, 2008).
7 **Other Types**	This includes anything not in codes one through six. Most plastics in this section do not breakdown and are considered permanently and chemically bonded. (S.A.V.E Foundation, 2016)

The conventional plastic average will complete degradable is take more than 10 year minimum. Even conventional plastic more than 200 years helping people until now the problem of the disposal of environmentally friendly. The plastic that do residue in landfills degrade very slowly, which may cause the original product to remain in our landfills for hundred or even thousand year (Sanjay Kumar et al, 2011).

2.4 Natural sources as matrix polymer

The application of biomass such as starch, cellulose, wood and sugar used to substitute fossil resources for the production of plastic, is most widely accepted strategy towards sustainable development (Valdés and Marina, 2015). Several bio polymer are produced from process of natural valuable raw materials such as wheat, corn, sugar, rice, potatoes, soy and tapioca. Starch is a condensation polymer made up of hundreds