UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PHYSICAL AND MECHANICAL PROPERTIES OF POLYPROPYLENE/RECLAIMED RUBBER COMPOUND

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) (Hons.)

by

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DECLARATION

I hereby, declared this report entitled “physical and mechanical properties of polypropylene/reclaimed rubber compound” is the results of my own research except as cited in references.

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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 of Manufacturing Engineering Technology (Process) (Hons.). The member of the supervisory is as follow:

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En. Hairul Effendy Bin Ab Maulod

ABSTRAK

Perkembangan pesat industri getah menghasilkan lebih banyak sisa getah. Oleh kerana ciri-ciri bukan getah mesra alam, ia menyebabkan pencemaran alam sekitar yang serius. Oleh itu kitar semula getah sisa telah menjadi masalah yang semakin meningkat daripada strategi global. China adalah pengeluar produk getah terbesar di dunia dengan penggunaan tahunan 3,700,000 tan getah. Termoplastik menunjukkan kepentingannya dalam produk kejuruteraan. Daripada kedua-dua bahan permukaan patah bahan gagal untuk menentukan kaedah pembentukan retak dan lanjutan. Termoplastik (TPE) muncul kepentingannya dalam dalam produk kejuruteraan. Ia adalah gabungan bahan getah dan plasti. Daripada kedua-dua bahan, permukaan patah bahan gagal untuk menentukan kaedah pembentukan retak dan lanjutan. Polypropylene (PP) telah dipilih kerana mempunyai ciri-ciri yang istimewa. Untuk kajian ini, PP / RR kompaun akan menjalani beberapa ujian iaitu ujian mekanikal dan fizikal akan dilakukan oleh PP / RR kompaun. Hasilnya akan dibandingkan berdasarkan peratusan yang berbeza daripada PP dan kompaun RR dalam komposisinya. Terdapat untuk komposisi termasuk sampel kawalan. Terdapat 100PP / 0RR, 90PP / 10RR, 70PP / 30RR dan 50PP / 50 RR. Hasil kajian ini menunjukkan bahawa peningkatan kandungan getah, nilai sifat-sifat mekanik akan menjadi penurunan dan keanjalan kompaun akan meningkat.

ABSTRACT

The rapid development of rubber industry produces more and more waste rubber. Due to rubber's non-biodegradable characteristics, it causes serious environmental pollution. Thus waste rubber recycling has been an increasing problem of global strategy. China is the biggest rubber products consuming country in the world, the annual consumption of 3700000 tons of rubber. Reclaimed rubber will help to develop rubber product. Thermoplastic (TPEs) has emerged its importance in in engineering product. It is the combination of the rubber and plastic materials. From these two material, the fracture surface of failed material to determine the method of crack formation and extension. Polypropylene (PP) has been choosing due to its special characteristic. For this study, PP/RR compound will undergo several testing which are mechanical and physical testing will be done by PP/RR compound. The result will be compared based on the different percentage of the PP and RR compound in its composition. There are for composition including the control sample. There are 100PP/0RR, 90PP/10RR, 70PP/30RR and 50PP/50 RR. The result of this study shows that the increasing of the rubber content, the value of the mechanical properties will be decrease and the elasticity of the compound will be increase.

DEDICATIONS

This report is dedicated to Mr Hairul Effendy Bin Ab. Maulod for his supervision, advices, and guidance during my period of study. To my beloved family, friends and lecturers which have been the source of my inspiration to undergo this project to a success. Thank you for all the support and encouragement from the start until end.

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0	Degree
C	Celsius
MM	Millimetre
RR	Reclaimed Rubber
PP	Polypropylene

CHAPTER 1

INTRODUCTION

1.1 Introduction

In manufacturing industrial product, plastic is a general terms for a wide range of synthetic or semisynthetic organic amorphous solid materials. It is because of the it's malleability and plasticity during manufacturing process. The properties of the plastic also allow them to be cast, pressed, or extruded into an enormous variety of shapes. Most of the plastic contain polymer. The wide majority of these polymers are based on chains of carbon atom alone or with another element like oxygen, sulphur or nitrogen as well. The properties of the polymer are affected by its structural. It can be said because of the fine tuning repeating unit in the polymer itself. Most of the plastic that usually used in our daily life is not 100% plastic because it will have other organic or inorganic compound when blend in together. As the example is wrap food. For this product, the amount of the additive ranges is from zero percentage but for certain electronic the percent of its additive is more than 50%. However, the average content of the additive is 20% by weight of the polymer.

Besides that, plastic also famous with a low cost material and versatility material. The use of the plastic is rapidly increased and it is an enormous and expanding range of product like a paper clip to spaceship. Due to its properties, it can displace many traditional materials such as wood, stone, bone, glass and ceramic. The use of plastic is constrained primarily by their organic chemistry, which seriously limit their hardness, density and their ability to resist heat. In particular,

most plastic will melt or decompose when heated to a few hundred degrees celsius. While plastics can be made electrical conductive to some extent, they still have not match for metal like cooper or aluminium.

A thermo softening plastic or a thermoplastic is a polymer that when heated turn into liquid or will turn into glass like when it is frozen. In general, thermoplastic usually have high molecular weight. Unlike Bakelite, this material is thermoset and once it hardened, it will stay that way. These polymers can be melted and remoulded, making them a great product for recycling.

In this study, polypropylene (PP) and reclaimed rubber (RR) will be blend in together in Haake internal mixer. By mixing these two material, it will form thermoplastic elastomer material (TPEs). The mechanical properties will be finding out in this research.

1.2 Problem Statement

The thermoplastic rubber is more commonly called as thermoplastic elastomer (TPEs). This class of material has properties for both of rubber and thermoplastic. The used of TPEs is increasingly due to the significant cost saving possible because their ability to be processed on plastic machinery. Conventional rubber, whether natural or synthetic, is a thermosetting material that must undergo a chemical cross-linking reaction during moulding extrusion, typically called curing or vulcanization. Due to this reaction, it is not general processable in standard thermoplastic equipment. The thermoplastic moulding and extrusion processes used for TPEs, on the other hand, avoid the cross-linking step and can achieve very fast cycle time, which can be as little as 20 second. In various rubber article formulation reclaimed is a product of discard rubber article it has gain much importance as additive. It is true that mechanical properties like tensile strength, modulus resilience and tear resistance are all reduce with the increasing amount or reclaim rubber in a fresh rubber formulation. But at the same time, the reclaim rubber provides many advantages if incorporated in fresh rubber. The increase in the awareness of waste management and environment related issues has led to substantial progress in the utilization of rubber waste. Recycling material back into its initial used often are more sustainable rather than finding new application.

1.3 Objective

The objective of this project:

1) To study the formulation of polypropylene/reclaimed rubber compound.
2) To prepare propylene/reclaimed rubber compound through melt compounding.
3) To determine polypropylene/reclaimed rubber compound physical and mechanical properties.

1.4 Scope

In this project, the material which is polypropylene and reclaimed rubber will be formed by blend with other material in mixing machine and go through with another process. The polypropylene and reclaimed rubber will be tested with the ability of the material to face the stress during its life.

1.5 Outline

This study has been organized into 5 chapters. Chapter 1 introduces the rationale of current study on alternative fuels. It discusses the challenges of current research have to undertake. The scope and objectives are also presented

Chapter 2 begins with the literature background of this study. It discusses on engineering rubber components in due to its widely use in manufacturing. Also discuss about olypropylene and reclaimed rubber.

Chapter 3 then present the methodology of the study conducted. Chapter 4 then continues with result and discussion of the study. Chapter 5 finally conclude and also future recommendation of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explains about all findings obtained from many literature reviews, which may come from the internet, journals, article and books about the topic related to this study.

2.2 Polymer

Based on the new understanding polymer synthesis and the development of commercialization of economical manufacturing method for a range of monomers, most of the major commodity and engineering plastic in current use were being manufacturer in 1950's. Figure 2.1 illustrate difference of monomer and polymer. During the same period, polymer blending began to embellishment. It was gradually accepted that new economical monomer were less likely but a range of new material could be developed by combining different existing polymer. While most monomer are available cannot be co-polymerize to a product of intermediate properties, their polymer could be melting blended economically.

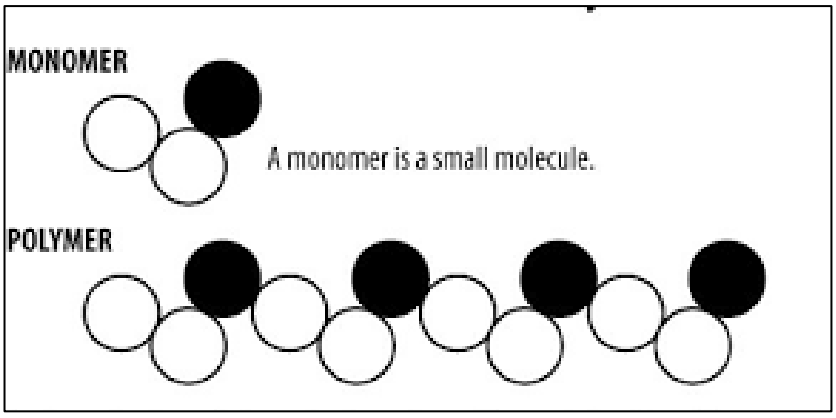

Figure 2.1: Structure of monomer and polymer

The physical properties of blends can be changed to satisfy a wide range of ratios. A desirable performance can be achieved by suitable selection of blend ingredient, followed by control of morphological by appropriate method of compatibility, compounding and processing. Blending process is known to improve the impact strength, mechanical properties, chemical and solvent resistance to enhance the process, abrasion resistance and flame retard. The improvement of the process is the most important criteria as the emphasis is shifting to high performance.

PP is the largest group of commodity by thermoplastic because of the ease of the process and the important thing is low cost. The main of the reason for its popularity is the development of blending technology for property modification. PP also known as a versatile polymer that continues to develop rapidly because of its superb performance and improvement in production economies. The blend this material has attracted much commercial interest. Other than that, the use of PP blend application can be found in automobile, appliance, house ware, furniture, sporting good and industrial component. The most of these manufacturing components process use injection moulded (Heikens 1973).

In polymer blends, properties like ductility and impact strength should be improved by compatibility. It is done by addition of block or graft copolymer with segment capable of interacting with blends constituents. These copolymers lower the interfacial tension and improve adhesion the matrix and dispersed phase (Dagli 1991; N.G.M. 1977). In contrast, there will there a lot of blend which are totally immiscible

and incompatible when blended together. It is due to the difference in material characteristic in terms of molecular weight crystalline, and polarity. As a result, these incompatible blends will exhibit poor properties in physical and mechanical. These problems can be solved by the addition of compatibiliser or filler which is consist of modification of the interfacial properties of the blend phase by using a suitable which located at the interfacial between the phases of an immiscible blend and act as an emulsifying agent.

Based on the previous study, the use of PP has been set its limitation in terms of impact resistance at low temperature and poor environmental stress cracking resistance. These properties of the PP can be improved by incorporation with another material.

2.3 Thermoplastic Elastomer (TPEs)

A method to a high level of quality is offered by blending rubber powder with thermoplastic to form material similar to thermoplastic elastomer. TPEs having characteristic of elastomer while retaining process and recycling ability of thermoplastic have been a serious interest to scientists and manufacturer for many years (Karger-Kocsis J. 1999). Thermoplastic vulcanized (TPVs), blends obtained by dynamic vulcanization of rubber in the thermoplastic matrix are of particular interest (Dubinin S. 2008). Similar material can be prepared by replacing a part or total amount of the virgin rubber by ground waste rubber.

TPEs are defined as a group that exhibit instantaneous reversible deformation. Most of the TPEs consist of continuous phase that exhibits elastic behaviour and dispersed phase that represent the physical cross-link. If the dispersed phase is elastic then the polymer is a toughened thermoplastic, not an elastomer. Elastomer reversibility must have physical crosslink. Therefore, these crosslink must be reversible. Physical crosslink do not exist permanently and may disappear with the increase of the temperature. This blend property can be acquired through the presence of soft elastic segment that have extensibility and low glass transition temperature, Tg and therefore are subject to crosslinking. The low glass transition temperature will be maintained because of the rubber phase, while high glass transition temperature of thermoplastic could help in medical integrity. Knowledge of microscope morphology of the blends is important for predicting the macroscopic properties. Enthalpy of mixing, glass transition temperature, dynamic mechanical properties, scanning electron microscopy, transmission electron microscopy and atomic force microscopy that have been utilized extensively for understanding the morphology of these blends (S.S. Banerjee 2005; M. Maiti, A. Bandyopadhyay 2016).

One of the top advantage of TPE is they allow the rubber to be produced by a quick processing technique as thermoplastic industries. The physical properties of rubber that can get from the TPE are as softness, flexibility and resilience (Nakason, C., Worlee, A., and Salaeh 2008; Bhowmick, A., and Stephens 1998).

A thermoplastic elastomer has all the same feature as described for an elastomer except that chemical crosslinking is replaced by a network of physical crosslinks. The ability to form physical crosslink is opposite to the chemical and structural requirement of an elastomer. The thermoplastic elastomer must be two phase materials and each molecule must consist of two opposite type of structural, one of the elastomeric part and the second the restraining and physical crosslinking part. Thermoplastic elastomer are typically blocked copolymers. The elastic block should have high molar mass and possess the other entire characteristic required of an elastomer. The restraining block should resist viscous flow and creep.

Thermoplastic elastomer are technologically very attractive because they can be processed as thermoplastic, this is their main advantage compared with crosslink elastomer. They can be remelted or devitrified and shape again. Hence, they are generally processed by extrusion and injection moulding, which the common are processing method used by thermoplastic. The advantage is the TPE has an operating temperature below that at which the hard phase become dimensionally unstable. Several factor need to be taken into account during the processing of TPEs, including viscosity or rheology of the two phase polymer, temperature and thermal stability since the complex structure will have potential to have a several weak chemical links (Kong 2008).

2.4 Thermoplastic

Thermoplastic are also known as thermo softening plastic because they become malleable when heated. Although they flexible above a certain heat threshold, they return to a solid once they have been sufficiently cooled. This is a contrast to most other type of plastic, which are unable to return to a solid state after they have heated beyond a certain point. For this reason, thermoplastic are put to unique uses in a rubber of manufacturing and engineering industries. Apart from their primary characteristic, thermoplastic vary slightly in usage and properties. For example, PP is a hard, water resistance thermoplastic. This is make an excellent

choice for creating toy models and for packaging that will not be exposed to extreme heat source in transit.

The polymer polyethylene, polypropylene, polybutylene, polystyrene and polymethylpentene are made up of only carbon and hydrogen items. Polyvinyl chloride has carbon and chlorine as its backbone. Linear polymer that lack specific order or are amorphous are arranged in a similar fashion to the way that spaghetti noodles look on a plate. These polymers have an amorphous arrangement of molecules, which means that there is no long range order to form that the polymer chain arrange themselves in. amorphous polymer also typically transparent. Common amorphous polymers are suitable to make food wrap, plastic window, contact lens and headlight lenses.

Scientists and engineer often manipulate the molecules structure of the polymer in order to produced more useful materials. By manipulating the molecular structure, scientist and engineer can create different product possibilities. Common molecular structure manipulation includes introducing filler, reinforcement and additive. Most of the polymer that is manufactured is thermoplastic, which means that once the polymer has formed it can be reformed repeatedly through reheating technique. These are the advantages and disadvantages of the thermoplastic.

Advantages of the thermoplastic:

1) The softening or melting by heating allows welding the thermoforming.

2) The process cycles are very short because of the absence of the chemical reaction of crosslinking.

3) The processing is easier to monitor because there is only a physical transformation

4) TPEs do not release gasses or water vapour if they are correctly dried before processing.