UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TENSILE BEHAVIOR STUDY OF POLYPROPYLENE AT DIFFERENT ASH LOADING

This report submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Process and Technology) (Hons.)

by

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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 Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

…….

En. Hairul Effendy Bin Ab Maulod

ABSTRACT

These days, productions of polymer composite often involve huge investment in material achievement. Productions polymer got famous due to light in weight, foldability in any shape, non-destructive in nature, mixture of colours, spare the application of plant woods for household furniture or more all reusability and so on. One way of reducing the production cost but still maintaining the properties of the composite is by using a filler such as coal ash. Coal ash had been choose due their availability, low cost, low density and recyclability. This study is focusing on effect of tensile behavior for polypropylene at different ash filler loading. In order to produce material compound, different composition had been studied to improve their physical and mechanical properties. The optimum compounding formulation of the material compound was observed at the combination of polypropylene and coal ash based on 100 wt. % of the polypropylene (PP) and different loading coal ash (CA) at 1, 2, 5, 7 and 10 wt. %. In order to improve the interfacial interaction between PP and CA, stearic acid was used as coupling agent at composition of 1 wt. %. The material compound went the compounding process using hot compression molding at 190℃ and crushing process by using crusher machine. Afterward, cutting process was done by using waterjet machining according to ASTM dimensions and then the compound was performed tensile test and density to determine the several of mechanical properties and physical properties. The morphological study of the compound was done by using optical microscope. It can found that the polypropylene with coal ash compounding was decreasing in term of tensile strength at 6.109 MPa since the drop in strength with addition of coal ash. The highest value in tensile strength was achieved at pure PP which is 9.067 MPa. Therefore, coal ash was found to reduce mechanical strength of PP.

ABSTRAK

Hari ini, pengeluaran komposit polimer sering melibatkan pelaburan besar dalam pencapaian bahan. Pengeluaran polimer terkenal kerana berat yang ringan, kelembapan dalam bentuk apa pun, bersifat tidak merosakkan, campuran warna, gantian aplikasi kayu tumbuhan untuk perabot rumah tangga atau boleh diguna semula dan sebagainya. Satu cara untuk mengurangkan kos pengeluaran tetapi masih mengekalkan sifat komposit adalah dengan menggunakan pengisi seperti abu arang batu. Abu arang batu telah dipilih kerana ketersediaan, kos rendah, kepadatan rendah dan kitar semula. Kajian ini memberi tumpuan kepada kesan tegangan untuk polipropilena pada pemuatan pengisi abu yang berbeza. Untuk menghasilkan sebatian bahan, komposisi yang berbeza telah dikaji untuk meningkatkan sifat fizikal dan mekaniknya. Perumusan penggabungan optimum bahan sebatian diperhatikan pada gabungan polipropilena dan abu arang batu berdasarkan 100 wt. % daripada polipropilena (PP) dan sebilangan besar abu arang batu (CA) pada 1, 2, 5, 7 dan 10 wt. %. Bagi meningkatkan interaksi interfacial antara PP dan CA, asid stearik digunakan sebagai agen gandingan pada komposisi 1 wt. %. Komponen bahan tersebut menjalani proses pengkompaunan menggunakan acuan mampatan panas pada 190 °C dan menghancurkan proses dengan menggunakan mesin penghancur. Selepas itu, proses pemotongan telah dilakukan dengan menggunakan pemesinan airjet mengikut dimensi ASTM dan kemudian sebatian dilakukan ujian tegangan dan ketumpatan ujian untuk menentukan beberapa sifat mekanik dan sifat fizikal. Kajian morfologi kompaun itu dilakukan dengan menggunakan mikroskop optik. Ia dapati bahawa polipropilena dengan pengkompaatan abu batubara berkurangan dalam kekuatan tegangan pada 6.109 MPa sejak kejatuhan kekuatan dengan penambahan abu arang batu. Nilai tertinggi dalam kekuatan tegangan dicapai pada PP tulen iaitu 9.067 MPa. Oleh itu, abu arang batu didapati mengurangkan kekuatan mekanikal PP.

DEDICATION

Specially dedicated to
my beloved family, lecturers and all everyone who had contributed to complete my project.

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TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF EQUATION

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

Al_2O_3	-	Aluminium Oxide
ASTM	-	American Society for Testing and Materials
BTU	-	British thermal unit
C	-	Carbon
CA	-	Coal Ash
$CaCO_3$	-	Calcium Carbonate
CESP	-	Calcinated Eggshell Powder
ES	-	Eggshell
ESP	-	Eggshell Powder
FA	-	Fly Ash
FeO/Fe_2O_3	-	Iron Oxide Powder Synthetic Ferrous Oxide
g	-	Grams
kg	-	Kilograms
MgO	-	Magnesium Oxide
$Mg(OH)_2$	-	Magnesium Hydroxide
OM	-	Optical Microscope
PHP	-	Per Hundred Polypropylene
PP	-	Polypropylene
PP/ESP	-	Polypropylene Eggshell Powder Composite
RHA	-	Rice Husk Ash
Sb_2O_3	-	Antimony Trioxide
SiO_2	-	Silicon Dioxide
U.S	-	United State
UTM	-	Universal Testing Machine
ZnO	-	Zinc Oxide
$	-	Dollar
%	-	Percentage
ºC	-	Degree Celsius

°F	-	Fahrenheit
σ	-	Stress
ϵ	-	Strain
wt %	-	Weight Rates
ft	-	Feet
in	-	Inch
lb	-	Pound
kpsi	-	Kilo pound per square inch
kHz	-	Kilo Hertz
psi	-	Pound per square inch

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter will explain the overview and the purpose of this study. This chapter includes the background of the study, problem statement, objectives that is expected to be achieved and the scope of the study that is going to be conducted.

1.1 Research Background

During the previous decades, numerous polymer composites have been arranged joined with different sorts of strengthening fillers to enhance the mechanical properties and acquire the qualities requested in actual applications. The employments of characteristic filler for the reinforcement has gotten expanding consideration in industry division. Regular filler have numerous essential points of interest, for example, their low density, low economical costs, and capacity to reduce scratched of machine (Rale, S D, 2012). The expansion of different sorts of filler is known to essentially impact the crystallinity of polymers filling in as the structure materials, hence influencing the mechanical properties of composites.

In a polymer family, polypropylene is a crucial substance of thermoplastic polymer used extensively in Malaysia consisting of packaging and labelling, textiles, stationery, plastic elements, production, and car components. Its low density, low production fees, design flexibility and recyclability make it a popular desire as matrix

fabric (Oljaric, Steven, 2009). Filler-reinforced polypropylene has been a famous due to versatility of the polypropylene to accept numerous forms of fillers and reinforcements. Fillers which merely growth bulk extent consequently reduce fee, are called extender fillers while the ones enhance mechanical residences specifically tensile strength are termed as reinforcing fillers (Yang, Han-seung, 2004).

This study is focusing on tensile behavior study for polypropylene at different ash filler loading. Productions of polymer composite often involve huge investment in material achievement. One way of reducing the production cost but still maintaining the properties of the composite is by using natural filler such as coal ash. Coal ash had been choose due their availability, low cost, low density, high specific strength and modulus, and recyclability. Polypropylene is mixed with hot press at around 190°C. The compound later crushed by using crusher machine. Afterwards, the samples will undergone tensile behavior using universal tensile machine.

At the end of this project, expected result is to perform tensile results of polypropylene with filler coal ash compound and to present tensile strengths according to the filler coal ash compound.

1.2 Problem Statement

These days, the creations of polymer composites, polypropylene are frequently include enormous interest in material accomplishment. So as to minimize the creation cost of plastic items and to enhance certain attributes, at least one fillers are generally utilized as an expansion to the strength matrix. Since of the ecological concerns and transfer challenges, the use of coal ash has happened to extraordinary significance (Kumar, Baljeev, 2012). The tendency to utilize coal powder as a filler or reinforcement in metal and polymer structures is that coal ash remains is a by-result of coal burning, accessible in huge amounts at low expenses since a lot of this as of now land filled.

Polypropylene require reinforcement or filler with a specific end goal to diminish the creation expenses of formed items and also enhancing the mechanical properties, for example, quality, inflexibility, toughness and hardness. Polypropylene mostly utilize inorganic fillers which is comprising of minerals. Coal ash is extremely appropriate as a filler since it is comprised of 95% of the mineral matter present in coal which is made out of mud, pyrite and calcite. So that, filler from inorganic mineral can be blended with polypropylene as they can diminish consumes from landfills so as to enhance mechanical properties in real applications.

In the current work, the formulation of polypropylene mixing with modified coal ash compound had been studied. Furthermore, the effect of tensile behavior of polypropylene with coal ash compound as a filler will be tested to get the best formulation on the mixing of polypropylene with coal ash compound.

1.3 Objectives

The objectives of this study can be outlined as the following:

i. To study current formulation of Polypropylene (PP) with Coal Ash (CA) compound
ii. To prepare Polypropylene (PP) with filler Coal Ash (CA) compound.
iii. To study the effect of the tensile behavior of Polypropylene (PP) with Coal Ash (CA) compound.

1.4 Scopes

This study is to study the tensile behavior of polypropylene with coal ash compound through the mixing material using compression molding followed by mechanical testing such as tensile test in order to determine the effect and properties of the composites.

1.5 Organization of research study

This study has been composed into 5 sections that represent the methodical and experimental research performed. Chapter 1 is a prologue to the present review that clarify about objectives, problem statement, significant of study and the thesis overview.

Chapter 2 starts on the writing literature background of this study. It talks about importance of polymer composites in Malaysia and the sorts of fillers utilized as a part of polypropylene. The essential component that incorporate into this section is the impact of mechanical properties for polypropylene at different ash filler loading.

Chapter 3 gives points of interest explanations on the approach utilized for general research work, raw materials, and technique property investigation that had been finished. Chapter 4 then proceeds with result and discussion of the review. At long last, Chapter 5 finish up the general research of study and furthermore future suggestion of this study.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter describes about all findings gained from many literature review, which may gotten from the internet, journals, articles and books about the topic related with this study. This section involves findings about the overview of polypropylene (PP), and some type of fillers which are utilized in polypropylene (PP).

2.1 Polymers

2.1.1 Historical development of polymer

Before we proceed into specifics of the science of polymers, it is suitable to briefly summary a few of achievements in the historical development of what we now know as polymers. Polymers have been with us from the starting of time which is they form the very basis (building blocks) of life. Creatures and plants whereas all classes of living organisms are made out of polymers. In any case, it was not until the center of the twentieth century that we started to realize the real idea of polymers. This understanding go with the improvement of plastics, which are true man-made materials that are a

complete tribute to man's inventiveness and creativity. As we should see in following discussions, the utilization of polymeric materials has encompassed each the feature of our lives. It is difficult to imagine the present world with all its magnificence and comfort without man-made polymeric materials.

The 1970s saw the presentation of new plastics which is thermoplastic polyesters (outside car parts, bottles), high-barrier nitrile resins, and the signified of high-temperature plastics, including such materials as polyphenylene, sulphide, polyether sulfone, and so on (Ebewele, Robert O., 2000). The high-temperature plastics were at first created to meet the requests of the aerospace and aircraft industries. Today, in any case, they have moved into business areas that require their capacity to work constantly at high temperatures.

In the years ahead, polymers will keep on growing. The development, from all signs, will be most certainly not just from the advancement of new polymers, yet in addition to the substance and physical adjustment of existing ones. Additionally, enhanced manufacture strategies will bring about minimal effort items. Today the difficulties of reusing postured by natural issues have prompted encourage improvements including alloying and mixing of plastics to distribute a several variety of usable materials from what have up to this point been thought about consumes.

2.1.2 Description and concept of polymer

The word polymer is gotten from traditional Greek poly representing "numerous" and meres representing "parts." Hence a polymer is an enormous particle (macromolecule) developed by the repetition of little compound units (Ebewele 2000). To explain this, Figure 2.1 presents the development of the polymer polystyrene.

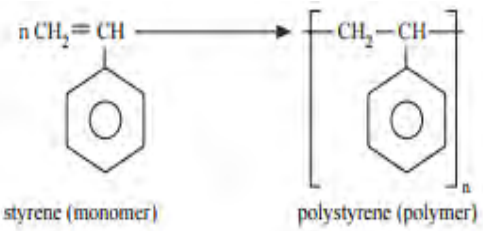
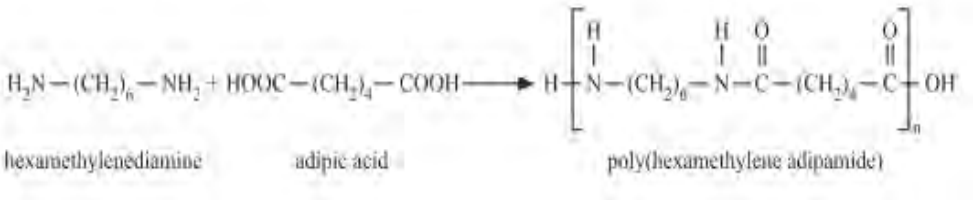


Figure 2.1 : Formation of polymer polystyrene (Ebewele 2000)

According to Figure 2.1, the styrene atom contains a double bond. Scientific experts have conceived techniques for opening this double a bond so that truly a large number of styrene particles end up noticeably connected together (Ebewele 2000). The subsequent structure, polystyrene enclosed in square sections, polystyrene. Styrene itself is stated to as a monomer, which is characterised as any atom that can be changed over to a polymer by joining with different particles of the same or different type. The unit in square sections is known as the repeating unit. So that the structure of the repeating unit is not precisely the same as that of the monomer despite the fact that both have indistinguishable particles possessing comparative relative positions. On behalf of polystyrene, the polymer is developed from a particular monomer (styrene) and, subsequently, the basic unit of the polystyrene chain is the same as its rehashing unit. Different cases of polymers of this type are polyethene, polyacrylonitrile, and polypropylene. At the same time, a few polymers are developed from the common reaction of at least two monomers that are artificially comparable but not indistinguishable. From example in Equation 2.1, formation of poly (hexamethylene adipamide) is made of the reaction of hexamethylenediamine and adipic acid.



Equation 2.1: Formation of poly (hexamethylene adipamide) (Ebewele 2000)