UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEGRADATION OF TENSILE PROPERTIES OF NATURAL RUBBER (NR) COMPOSITE AND TAPIOCA STARCH (TS) UNDER SOIL BURIAL TEST

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

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DECLARATION

I hereby, declared this report entitled “Degradation of Tensile Properties of Natural Rubber (NR) Composite and Tapioca Starch(TS) under Soil Burial Test” 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 Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

…….

En. Hairul Effendy Bin Ab Maulod

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ABSTRAK

Pada masa kini, permintaan antarabangsa yang tinggi terhadap getah asli memacu pengembangan berskala industri dan industri automotif. Disebabkan sifat-sifat tidak stabil Getah Asli (NR), pengubahsuaian sifat-sifat mereka perlu untuk diperbaiki. Kajian ini memberi tumpuan kepada "Degradasi Tegangan terhadap Getah Asli (NR) Komposit dan Tepung Ubi Kayu (TS) di bawah ujian biolupus". Tepung ubi kayu (TS) digunakan sebagai pengisi berasaskan organik untuk Getah Asli (NR) dan sebagai bahan matriks utama dengan menggunakan rumusan berdasarkan mencari peningkatan sifat-sifat fizikal dan mekanikal mereka. Objektif utama kajian ini adalah untuk mengkaji kesan isian tepung ubi kayu terhadap sifat-sifat Getah Asli untuk mewujudkan formulasi terbaik komposit degradasi Getah Asli (NR). Terdapat pelbagai pengisian di dalam kajian ini bermula dari 0-60 phr. Sampel komposit dihasilkan dengan menggunakan formula pencampuran yang berbeza dengan menggunakan kaedah campuran dan mampatan. Kemudian komposisi tersebut akan menjalani beberapa ujian termasuk ujian tegangan dan menyembuhkan ciri untuk menentukan kedua-dua ciri-ciri fizikal dan mekanikal. Sifat-sifat alam sekitar telah ditentukan melalui ujian biolupus dan ujian ketebalan. Morfologi sampel diperhatikan di bawah mikroskop optik. Peningkatan kadar tepung ubi telah meningkatkan kadar pelupusan dan pembengkakan tebal yang dihasilkan oleh komposit. Secara keseluruhannya, semua objektif kajian yang disenaraikan berjaya dicapai daripada kajian awal ini.

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ABSTRACT

Nowadays, strong international demand for natural rubber is driving expansion of industrial-scale and automotive industry. Due to unstable properties of Natural Rubber (NR), the modification of their properties are necessary to improve. This study is focused on the "Degradation of Tensile Properties of Natural Rubber (NR) Composite and Tapioca Starch(TS) under Soil Burial Test". Tapioca Starch (TS) is used as organic based filler for Natural Rubber (NR) and as a primary matrix material by using based formulation in search of improvement their physical and mechanical properties. The main objective of this research is to study the effect of Tapioca Starch loading on the properties of Natural Rubber as to establish the best formulation of the Biodegradable Natural Rubber (NR) composite. The filler loading was varied from 0-60 phr. The compositions were fabricated into thin sheets using a hot compression molding machine. The compound then will undergo a few testing includes of tensile testing and cure characteristic to determine both physical and mechanical properties. The environmental properties were determined through soil burying test and thickness swelling test. The morphology of the samples was observed under optical microscope. The increasing of tapioca starch (TS) content had significantly increased the degradation and swelling thickness of produced composite. In overall, all the listed research objectives were successfully achieved from this preliminary research.

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DEDICATION

This report is dedicated to Mr. Hairul Effendy Bin Ab. Maulod for without his early inspiration, coaching and enthusiasm, none of this would have happened. This dedication is specially dedicated to my parents. To my father, Mohd Safeai Bin Shari for his ongoing love and support, he also taught me to trust in Allah and believe in hard work and to my mother who could not see this final report completed. I also dedicate this report to my family who always support me with their unconditional love that motivates me to set a higher target in completing this final year project. This dedication is also dedicated to my beloved friends that have provided me with a strong love shield and always surround me and never lets any sadness enter inside.

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TABLE OF CONTENT

Abstrak		i
Abstract		ii
Dedication		iii
Acknowledgement		iv
Table of Content		v
List of Table		viii
List of Figures		x
List of Equation		xii
List of Graph		xiii
List of Abbreviations, Symbols and Nomenclature		xiv
CHAPTER 1: INTRODUCTION		**1**
1.0	Introduction	1
1.1	Research Background	1
1.2	Problem Statement	3
1.3	Objectives	4
1.4	Scopes	4
1.5	Organization of research study	5
CHAPTER 2: LITERATURE REVIEW		**6**
2.0	Introduction	6
2.1	Rubber	7
2.1.1	Types of Rubber	9
2.1.1.1	Natural Rubber	9
2.1.1.2	Synthetic Rubber	10
2.1.2	Properties of Rubber	11
2.2	Introduction of Natural Rubber	12
2.2.1	Properties of Natural Rubber (NR)	13
2.2.2	Application of Natural Rubber	14
2.2.3	Vulcanization of Natural Rubber	15

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2.2.3.1 How does Vulcanization make Natural Rubber strong? 16
2.2.3.2 Comparison between raw NR and Vulcanized NR 17
2.3 Fillers on Natural Rubber 18
2.3.1 Sources of Fillers Reinforcement Rubbers 19
2.3.2 Carbon Black (CB) 20
2.3.3 Non Black Fillers 21
2.3.3.1 Alumina Fillers 21
2.3.4 Waste Biomass 22
2.4 Tapioca Starch 23
2.4.1 Mechanical Properties of Tapioca Starch 24
2.4.2 Modified Tapioca Starch 25
2.5 Biodegradability 26
2.5.1 Biodegradation of Natural Rubber Composite 27
2.5.2 Types of Degradation Methods 28
2.5.2.1 Soil Burial Degradation 28
2.5.2.2 Degradation by Weather 29
2.5.2.3 Degradation by Compost 30
2.5.3 Aging of Rubber 31

CHAPTER 3: METHODOLOGY 32
3.0 Introduction 32
3.1 Methodology 32
3.1.1 Flow Chart of Methodology 33
3.2 Materials 33
3.3 Gantt Chart 35
3.4 Raw Material Preparation Process 36
3.4.1 Preparation of NR Compound 38
3.4.2 Preparation of Tapioca Starch 39
3.5 Characterization of Tapioca Starch 40
3.5.1 Drying Profile Study 40
3.5.2 Density Measurement 40
3.6 Sample Fabrication 41
3.6.1 Internal Mixer 41
3.6.2 Processing characteristic of Biodegradable NR Composite with TS 44

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3.6.3 Hot Compression Process 46
3.7 Machining Process 47
3.8 Material Testing 48
3.8.1 Tensile Test 48
3.8.2 Soil Burial Test of Natural Rubber 49
3.8.3 Rheometric Test- Cure Characteristic 50
3.8.4 Swelling Test 51
3.9 Analysis 52
3.9.1 Optical Microscope 52

CHAPTER 4: RESULT & DISCUSSION 53
4.1 Introduction 53
4.2 Density Measurement of Natural Rubber (NR) Composite 54
4.3 Cure Characteristic 57
4.4 Environmental Evolution Biodegradable NR Composite with TS 60
4.4.1 Weight Properties of Degradation NR with TS under Soil Burial Test 60
4.5 Mechanical Properties for Degradation of NR Composite with TS 66
4.5.1 Tensile Test Analysis for Degradation of NR Composite with TS (7 Days) 66
4.5.2 Tensile Test Analysis for Degradation of NR Composite with TS (14 Days) 69
4.5.3 Tensile Properties Results Before and After Soil Burial Test 71
4.6 Thickness Swelling Properties for Biodegradable NR Composite with TS 72
4.7 OM Analysis on Tensile Fractured Surface of Degradation of NR with TS 76

CHAPTER 5: CONCLUSION AND RECOMMENDATION 79
5.1 Conclusion 79
5.2 Recommendation 80

REFERENCES xv

APPENDIX xx

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LIST OF TABLE

CHAPTER 2

Table 2.1	Example Formulation of Automotive (Tire)	8
Table 2.2	Comparison Between Raw NR and Vulcanized NR	17
Table 2.3	Iodine affinities (IA) and amylose contents of cassava and modified starch	25

CHAPTER 3

Table 3.1	Gantt Chart	35
Table 3.2	Material B/ Tapioca Starch Formulation	39
Table 3.3	The Natural Rubber with Tapioca Starch Formulation in PHR	41
Table 3.4	The Natural Rubber with Tapioca Starch Formulation in grams (g)	42
Table 3.5	The Natural Rubber with Tapioca Starch Formulation in (1000g)	43

CHAPTER 4

Table 4.1	Density Measurement NR-TS (0)	54

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Table 4.2	Density Measurement for other Formulation	56
Table 4.3	Curing Parameters of NR-TS	59
Table 4.4	Weight before and after Burying Test [D-7]	61
Table 4.5	Weight before and after Burying Test [D-14]	63
Table 4.6	Tensile Properties of NR/TS [7 Days]	68
Table 4.7	Tensile Properties of NR/TS [14 Days]	70
Table 4.8	Thickness Percentages of Swelling Test [D-0]	73
Table 4.9	Thickness Percentages of Swelling Test [D-7]	73

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LIST OF FIGURES

CHAPTER 2

Figure 2.1	Rubber Product (Tire)	8
Figure 2.2	Latex Rubber	12
Figure 2.3	Molecules of Latex Rubber and Vulcanized Rubber	16
Figure 2.4	Natural Rubber and Silica Fillers	18
Figure 2.5	Morphological of Carbon Black Particles	20

CHAPTER 3

Figure 3.1	Flow Chart	34
Figure 3.2	Material Preparation	37
Figure 3.3	NR after Mixing	38
Figure 3.4	Drying TS in the Oven model UFB 400,Memmer	39
Figure 3.5	Electronic Densimeter	40
Figure 3.6	Haake Rheomix OS	42
Figure 3.7	Haake Rheomix OS in Rubber Industry	43
Figure 3.8	Mixing Process Flow	45
Figure 3.9	Hot Press Machining	46
Figure 3.10	Results of NR+TS after Hot Press	46
Figure 3.11	Cutting Process using Waterjet Machine	47
Figure 3.12	Results of Cutting Process	47
Figure 3.13	Standard Specifications of Sample Dimension	48
Figure 3.14	Soil Burial Test	49

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Figure 3.15 Optical Microscope 52

CHAPTER 4

Figure 4.1 Cure Characteristic of Rubber 58

Figure 4.2 Before Soil Burial Test 65

Figure 4.3 After Soil Burial Test 65

Figure 4.4 Tensile Testing 67

Figure 4.5 Swelling Test 75

Figure 4.6 Thickness Result after Swelling Test 75

Figure 4.7 OM Micrograph showed the Fracture Surface of NR-TS (0) 76

Figure 4.8 OM Micrograph showed the Fracture Surface of NR-TS (20) 77

Figure 4.9 OM Micrograph showed the Fracture Surface of NR-TS (60) 78

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LIST OF EQUATION

Equation 2.1	Structure of Isoprene- Monomer of NR	9
Equation 2.2	Structure of Synthetic Rubber	10
Equation 3.1	Swelling Percentage	51

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LIST OF GRAPH

Graph 4.1	Density Measurement NR/TS	56
Graph 4.2	Percentage of Weight Reduction after 7 Days of Burial	63
Graph 4.3	Percentage of Weight Reduction after 14 Days of Burial	64
Graph 4.4	Tensile Strength versus TS Content of NR/TS Blends [7 Days]	68
Graph 4.5	Tensile Strength versus TS Content of NR/TS Blends [14 Days]	70
Graph 4.6	Thickness Percentage of Swelling Test	74

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

Al2O3	-	Aluminium Oxide
C	-	Carbon
CB	-	Carbon Black
CH	-	Carbon
DMA	-	Dynamic Mechanical Analysis
F	-	Fahrenheit
IA	-	Iodine affinities
NR	-	Natural Rubber
OM	-	Optical Microscope
PHR	-	Per Hundred Rubber
RM	-	Ringgit Malaysia
SR	-	Synthetic Rubber
TS	-	Tapioca Starch
U.S	-	United State
UTM	-	Universal Testing Machine
%	-	Percentage
^{o}C	-	Degree Celcius
σ	-	Stress
ϵ	-	Strain

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CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter will explain the overview of the study and the purpose of this study. The 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

Nowadays, the demand of rubber product is increasing. The use of rubber in so many applications results in growing volume of rubber products. Rubber is widely used in automotive industry because rubber is very durable and easily molded into a difference shapes. Automotive industry is the biggest consumer of rubber product with approximately 80% of the total rubber production. Tires are one of the most important parts of a car. Rubber also used for making numerous hoses, seals critical to the functioning of car's engine and belts.

Rubbers in general are rarely utilized as a part of their structure because of they are too weak to fulfill practical requirements for many applications, for example lack of hardness, wear resistance and strength properties, but when addition of particulate fillers the strength could be expanded 10 times. The using of the additives such as fillers, stabilizers, accelerators, pigments, plasticizers, etc (Adnan 2010).

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The fillers are utilized with various different parts called compounding ingredients. The use of fillers in rubber products is almost as old as the use of rubber itself because most of rubber applications is modified by joining with particulate fillers such as improve the process-ability, properties, performance and life of the final product, impart its color and reducing the cost.

The selection of any types of fillers that used in natural rubber is depend on the property requirement of the end rubber product. The use of reinforcing fillers in tyres improves both the strength and stiffness characteristics of the rubber polymer (Adnan 2010). Natural rubber can be developed by reinforcement with carbon black, silica, calcium carbonate particle but this process provides a high cost of final products. Tapioca starch is one of natural resources filler that used in natural rubber (NR). Using of low cost filler from natural resource is one alternative to reduce cost of Natural Rubber (NR) products (Changpanao 2015).

This study is regarding the "Degradation of Tensile Properties of Natural Rubber (NR) Composite and Tapioca Starch(TS) under Soil Burial Test". The effects of different types of fillers on Natural Rubber compounds have been studied, in search of improvements on their physical and mechanical properties. The tapioca starch will use as organic nature fillers due to their low cost, light weight, environmentally friendly nature, and because they enhance the mechanical properties of the filled materials. Thus, this study is aimed at the potential use and the mechanical properties before and after degradation of Natural Rubber (NR) composite under soil burial test.

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1.2 Problem Statement

Natural Rubber normally uses in industry that producing automobile tires, gaskets, hoses, personal protective equipment and etc. The demands for rubber based products are increasing by time. Meanwhile the current price of natural rubber based on Malaysian Rubber Board is about RM12 per kg and is increasing by day. So, in economical view, it is not possible to produce rubber products by just using natural rubber only. In this case, a few materials are required which could be mixed with natural rubber to create same or better quality items up to the consumer expectations. By that, it is found that fillers can be the added substance and also functioning to improve the strength of natural rubber.

In addition, fillers from natural resources can be chosen to be mixed with natural rubber as they can reduce wastes from landfills. For that, modified tapioca starch is one of the natural fillers that used to improve the mechanical properties by finding possible applications. Furthermore, it may be a cheaper alternative in the future to process the natural rubber (Kamarah 2010).

Besides, the application of biodegradable material as an alternative choice is increasingly applied. Biodegradable which are often produced from renewable sources as part of a solution to environmental concerns over waste and the use of fossil fuels. Regarding the studies of on decomposition of natural rubber, numerous investigations have been made with microorganisms. The early studies were carried out to prevent degradation of rubber in soil.

In order to get the best formulation on the mixing of Natural Rubber compound (NR) with Tapioca Starch (TS) as a mixing materials in automotive industry, some research studies on the physical and mechanical properties of tapioca starch and natural rubber. The research on current formulation of tapioca starch to improve the types of fillers to mix it with Natural Rubber compounds. The best formulation on the mixing of Natural Rubber compound (NR) with Tapioca Starch (TS) will be interpreted in the industrial applications (Azwar & Hakkarainen 2012).

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1.3 Objectives

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

i. To study the current formulation between Natural Rubber (NR) composite and Tapioca Starch (TS).
ii. To prepare compound from Natural Rubber (NR) and Tapioca Starch(TS).
iii. To study the effect of the physical and tensile behavior of Natural Rubber (NR) compound with Tapioca Starch (TS) in term of degradation under soil burial test.

1.4 Scopes

The study on this topic can be benefit for certain circumstances. This research is to "Degradation of Tensile Properties of Natural Rubber (NR) Composite and Tapioca Starch(TS) under Soil Burial Test" through the mixing material using internal mixer followed by soil burial degradation testing and various physical and mechanical testing such as tensile test and swelling. Besides, some analysis regarding this project involve of Optical Microscope (OM) and Dynamic Mechanical Analysis (DMA). Moreover, this study is possible to commercialize and be a cheaper alternative in the future of rubber technology as there were no many researches on this specific topic (Kamarah 2010).

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1.5 Organization of research study

This thesis is divided into five chapters that describe the analytical and experimental research performed. This dissertation shows how modified tapioca starch used as a filler in natural rubber. The effects of different types of fillers on Natural Rubber compounds have been studied, in search of improvements on their physical and mechanical properties. The organization of this research study is as follows. This dissertation has been organized into 5 chapters. The first chapter is an introduction to the study that brief about objectives, problem statement, significant of study and the thesis overview

Chapter two begins on the literature background of this study. It discusses on engineering rubber that significance in Malaysia and the types of fillers that usually used in natural rubber. The important element that included in this chapter is about the mechanical properties and used of rubber and natural rubber.

Chapter three provides details explanations on the methodology used for overall research work, raw materials, procedure property analysis that had been done. In chapter four the result of the characterization and rheological of natural rubber and tapioca starch. The final chapter (Chapter 5) concludes the overall results obtained from this research. In this chapter, it explains either the objectives of this study are achieved or not. The recommendation for future project also has been included in this Chapter 5.

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CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In this chapter, it will explain about introduction of natural rubber and material used to mix with natural rubber (Tapioca Starch). The success of a design and material testing also depends on the creativity of designers and the use of appropriate technology to meet the needs of effective and functional. The design and study is ongoing process that involves creative problem solving is known as a literature.

The title development of natural rubber with tapioca starch requires an amount of good understanding on the knowledge of the science and material. Therefore, executing a research is necessary to obtain all the information available and related to the topic. The information or literature reviews obtained are essentially valuable to assist in the construction and specification of this final year project. With this ground established, the project can proceed with guidance and assertiveness in achieving the target mark.

In the production this project, all theory and information of material, substance used, production and testing in relation this project will be described to achieve objective of the project those implemented.

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2.1 Rubber

Rubber technology has a wonderful history. Over 150 years ago, the formula for rubber was established. The history starts from the jungle of Brazil to its designation as a strategic material during World War II (Ciesielski 1999). The primary material comes in many variations, and most of it is synthetic origin.

Rubbers are approximately depicted as materials which indicate "flexible" properties. Rubber are generally having a long chain molecules called “polymer”. Meanwhile, the combination of elastic and polymers has led to the alternative name of “elastomers”. Products produced using elastic have an adaptable and stable 3 dimensional chemical structure and can withstand under huge force distortions. For example, the material can be stretched over and over to at least twice from its original length. When the rubber material immediate release of the stress, it will return with force to its original length. Other than these properties the modulus of elastic is from hundred to ten thousand times lower compared with other strong materials like steel, plastics and pottery. Rubber is widely used in several of industry such as automotive industry (tire). This combination of the unique properties gives rubber its particular applications like seals, tyres and shock absorbers (B.V 2010).

Rubber seems to be a fairly straightforward word. Rubber, like cellulose, was also classed as a colloid. It is a substance which contains large aggregates of molecules. The French call it caoutchouc or ‘weeping wood’. The polymer then mixed with chemicals to make a rubber compound which is subsequently vulcanized. This compound is simply a physical mixture of chemicals and indeed a number of ingredients in the vulcanization might be present only as a physical blend. Normally, the vulcanized material is also called a rubber.

To produce rubber formulations, drawing from a potentially infinite variation of material combination, rubber technologies come out with the idea of formulation of a blend of primary raw gum elastomer with other chemicals. Machine mixer, extrude and mold the blend of material in this formulations known as the rubber compound.

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