



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**EFFECT OF MIXING RATIO ON THE MECHANICAL
PROPERTIES OF POLYPROPYLENE COMPOSITE**

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

by

HAZWANI BINTI HILMI

B050910129

901126-03-6112

FACULTY OF MANUFACTURING ENGINEERING

2013



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Effect of Mixing Ratio on the Mechanical Properties of Polypropylene Composite**

SESI PENGAJIAN: 2012/13

Saya **HAZWANI BINTI HILMI**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

- SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
- TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
- TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:

Lot 1388 Kg. Jias, Jln. Taliair,

17000 Pasir Mas,

Kelantan.

Cop Rasmi:

Tarikh: _____

Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Effect of Mixing Ratio on Mechanical Properties of Polypropylene Composite” is the results of my own research except as cited in references.

Signature :

Author's Name : HAZWANI BINTI HILMI

Date :

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 (Process) (Hons.). The member of the supervisory committee is as follow:

.....

ABSTRAK

Projek ini memberi perhatian kepada kesan nisbah pencampuran di atas sifat mekanik komposit polipropilena. Objektif eksperimen ini adalah untuk menyiasat sifat-sifat mekanikal bahan menggunakan ujian tegangan. Eksperimen telah dijalankan di Makmal Polimer dan Makmal Bahan yang terletak di Fakulti Kejuruteraan Permbuatan, UTeM. Tiga nisbah kenaf gentian-PP komposit digunakan ialah: 10%: 90%, 30%: 70% dan 50%: 50%. Bentuk spesimen yang digunakan adalah berbentuk tetulang anjing. Mesin *hot press* telah digunakan untuk menghasilkan komposit kenaf gentian-PP. Sifat-sifat mekanik kenaf gentian-PP komposit dan polipropilena diperolehi dari ujian tegangan. Daripada kajian ini, didapati bahawa modulus tegangan meningkat dengan peningkatan jumlah kenaf. Walau bagaimanapun, polipropilena tulen menunjukkan nilai bacaan yang lebih tinggi dalam kekuatan tegangan tetapi nilai bacaan yang rendah dalam modulus tegangan berbanding komposit polipropilena. Di samping itu, pemanjangan pada waktu patah untuk PP komposit (K10:0.610%, K10/1:1.033%, K10/3:1.233%, K10/5:1.237%, K30:0.407%, K30/1:0.513%, K30/3:0.617%, K30/5:0.817%, K50:0.200%, K50/1:0.407%, K50/3:0.407% and K50/5:0.510%) menunjukkan keputusan lebih rendah daripada polipropilena tulen, 0.613%. Oleh itu, sampel PP komposit dengan pengikat adalah lebih baik dalam kekuatan tegangan, modulus tegangan dan pemanjangan pada waktu patah daripada mereka yang tidak mempunyai pengikat.

ABSTRACT

This project focuses on the effect of mixing ratio on the mechanical properties of polypropylene composites. The objective of this experiment is to investigate the mechanical properties of material using tensile test. The experiment was performed at Polymer Laboratory and Materials Laboratory located in Faculty of Manufacturing Engineering, UTeM. Three ratios of the kenaf fibre-PP composite were used: 10%:90%, 30%:70% and 50%:50%. The shape of the specimen used was dog bone shape. The hot pressing machine for producing kenaf fibre-PP composite samples was used. The mechanical properties of kenaf fibre-PP composite and polypropylene were obtained by tensile test. From this study, it is found that the tensile modulus increases with increasing the kenaf loading. However, pure polypropylene shows higher reading value in tensile strength but low reading value in tensile modulus compared to polypropylene composite. Further, the elongation at break for PP composites (K10:0.610%, K10/1:1.033%, K10/3:1.233%, K10/5:1.237%, K30:0.407%, K30/1:0.513%, K30/3:0.617%, K30/5:0.817%, K50:0.200%, K50/1:0.407%, K50/3:0.407% and K50/5:0.510%) shows lower results than pure polypropylene, 0.613%. Thus, the samples of PP composite with binder were better in tensile strength, tensile modulus and elongation at break than those without binder.

DEDICATION

To my beloved parents Hilmi bin Jusoh and Zalilah binti Bedullah.

ACKNOWLEDGEMENT

First and foremost, I would like to express my deepest gratitude to my Project Supervisor, Dr. Mohd Amran Bin Md. Ali, thank you for the guidance given throughout this Final Year Project. His guidance, advice, encouragement, patient and support given throughout this project were greatly appreciated. Besides, I would also like to thanks to panels, Dr. Mohd. Hadzley Bin Abu Bakar and Dr. Raja Izamshah Bin Raja Abdullah for their support and guidance. Not forgotten, all lectures and technicians which involve during my completion of this project, their guidance and encouragement in helping me achieving my training objectives shall be not forgotten.

I would also like to thank my friends and also staff for support, guidance and cooperation through this training. Their views and tips are very useful. The whole time together really brought us together to appreciate the true value of friendship and respect of each other.

Last but not least, I would also like to thank to my parents for always support me and give me the strength to finish up this industrial training. Thanks for their encouragement, love and emotional support that they had given to me.

TABLE OF CONTENT

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Tables	viii
List of Figures	ix
List Abbreviations, Symbols and Nomenclatures	xii
CHAPTER 1: INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Objectives	3
1.4 Scopes of the Research	3
1.5 Organizational of the Report	4
CHAPTER 2: LITERATURE REVIEW	5
2.1 Engineering Materials	5
2.2 Composites	7
2.3 Polymers	10
2.3.1 Polypropylene (PP)	14
2.4 Natural Fibre	16
2.4.1 Kenaf	17
2.4.2 Natural Fibre Composites Applications	19
2.6 Polypropylene-graft-maleic anhydride	21
2.6 Hot Pressing	22
2.7 Tensile Test	24

CHAPTER 3: METHADODOLOGY	34
3.1 Introduction	34
3.2 Discussion and conformation on project title	36
3.3 Literature review on project title	36
3.4 Identify the material	36
3.5 Select the machine	38
3.5.1 Panalux Blender Machine	38
3.5.2 Vibratory-Sieve Shaker Machine	40
3.5.3 Particle Size Analyzer Machine	40
3.5.4 Hot Press Machine	42
3.5.5 Internal Mixer Machine	43
3.5.6 Shear Cutter Machine	44
3.5.7 Sample Cutter Machine	45
3.5.8 Universal Testing Machine	46
3.6 Indentify Ratio of Polypropylene Composite	48
3.7 Prepare Sample of PP-Composite	49
3.7.1 Procedure of Compounding Process	50
3.7.2 Procedure of Hot Pressing Process	52
3.8 Test the Sample	54
3.9 Collect the Experiment Data	54
3.10 Analyzed the Data	55
3.11 Discussion, Conclusion and Recommendation	55
CHAPTER 4: RESULTS AND DISCUSSION	56
4.1 Stress Strain Graph	56
4.1.1 Tensile Strength	57
4.1.2 Tensile Modulus	60
4.1.3 Percentage of Elongation	65
4.2 Discussion	68
4.2.1 Tensile Strength	68
4.2.2 Tensile Modulus	71
4.2.3 Percentage of Elongation	73

CHAPTER 5: CONCLUSION AND RECOMMENDATION	75
5.1 Conclusion	75
5.2 Recommendation	76

REFERENCES	77
-------------------	-----------

APPENDICES

A	Table of Gantt chart for PSM1
B	Table of Gantt chart for PSM2
C	Stress Strain Graph of PP Samples
D	Stress Strain Graph of K10 Ratio
E	Stress Strain Graph of K10/1 Ratio
F	Stress Strain Graph of K10/3 Ratio
G	Stress Strain Graph of K10/5 Ratio
H	Stress Strain Graph of K30 Ratio
I	Stress Strain Graph of K30/1 Ratio
J	Stress Strain Graph of K30/3 Ratio
K	Stress Strain Graph of K30/5 Ratio
L	Stress Strain Graph of K50 Ratio
M	Stress Strain Graph of K50/1 Ratio
N	Stress Strain Graph of K50/3 Ratio
O	Stress Strain Graph of K50/5 Ratio
P	Results of Particle Size Analyzer

LIST OF TABLES

2.1	Sample formulations of kenaf and PP compositions	9
2.2	Properties of polypropylene	15
2.2	Comparison of flexural properties of commercial available formaldehyde-based wood composites with data on-85% filled kenaf-PP composite	38
3.1	Ratio of Polypropylene Composite	48
3.2	Ratio of PP composite in gram	49
4.1	Tensile Strength of PP and PP composites	60
4.2	Tensile Modulus of PP and PP composites	65
4.3	Percentage of Elongation of Pp and PP Composites	67

LIST OF FIGURES

2.1	Classification of engineering materials	6
2.2	Bar chart of room temperature stiffness (i.e., elastic modulus) values for various metals, ceramic, polymers, and composite materials	13
2.3	Bar chart of room temperature strength (i.e., tensile strength) values for various metals, ceramics, polymers, and composite materials	13
2.4	Bar chart of room temperature resistance to fracture (i.e., fracture toughness) for various metals, ceramics, polymers, and composite materials	14
2.5	Kenaf trees	18
2.6	Kenaf's part	18
2.7	Natural Fibre Polymer Sheets	20
2.8	Application of Natural Fibre Polymer	21
2.9	Others Application of Natural Fibre Polymer	21
2.10	Hot Press Machine	22
2.11	Graph of stress vs strain	24
2.12(a)	A standard tensile-test specimen before and after pulling, showing original and final gage lengths	25
2.12(b)	Stages in specimen behaviour in a tension test	26
2.13	A typical stress-strain curve obtained from a tension test, showing various features	27
2.14	Effect of Kenaf-PP Composition on Tensile Strength	28
2.15	Possible Schematic of Epolene 43 Treated Kenaf-PP Composites	29
2.16	The SEM Micrograph of Epolene 43 Kenaf Treated Sample	29
2.17	The SEM Micrograph of Untreated Kenaf-PP Sample	30
2.18	Effect of Kenaf-PP Composition on Tensile Modulus	31
2.19	Comparison of the tensile strength for three different types of	33

eco-core with journal

3.1	Flow Chart of Methodology	34
3.2	Kenaf fibre	37
3.3	Polypropylene (PP)	37
3.4	Polypropylene-graft-maleic anhydride	37
3.5	Kenaf fibre that was being cut	38
3.6	Panalux Blender Machine	39
3.7	Blend of Kenaf Fibre	39
3.8	Vibratory sieve-shaker machine	40
3.9	Kenaf fibre taken to analyze	41
3.10	Particle Size Analyzer Machine	41
3.11	Mastersizer 2000 software	42
3.12	Hot Press machine	43
3.13	Internal mixing machine	44
3.14	Shear cutter machine	44
3.15	Sample cutter machine	45
3.16	Dog bone shape samples	45
3.17	Universal Testing machine	46
3.18	Tensile Testing of Sample	47
3.19	Trapezium software	47
3.20	Schematic flow diagram of polypropylene composite	50
3.21	File created in HAAKE PolySoft OS	51
3.22	Temperature and speed of internal mixer machine	52
3.23	Set temperature on hot press machine	53
3.24	Compound in hot press mould	53
3.25	Dimension of sample	54
4.1	Stress Strain graph (K10/0 sample)	56
4.2	Tensile test data of K10 (sample 1) ratio	57
4.3	Tensile test data of K10 (sample 2) ratio	58
4.4	Tensile test data of K10 (sample 3) ratio	58

4.5	Stress strain graph of PP (sample 1)	61
4.6	Stress strain graph of PP (sample 2)	62
4.7	Stress strain graph of PP (sample 3)	63
4.8	Effect of PP, Kenaf-PP Composition on Tensile Strength	68
4.9	Possible Schematic of Epolene 43 Treated Kenaf-PP Composites	69
4.10	Tensile strength results done by Saad, M. J. (2011) in his study	70
4.11	Effect of PP and Kenaf-PP Composition on Tensile Modulus	71
4.12	Tensile Modulus results done by Saad, M. J. (2011) in his study	72
4.13	Effect of PP, Kenaf-PP Composition on Elongation at Break	73
4.14	Elongation at Break results done by Saad, M. J. (2011) in his study	74

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

A_o	-	Cross-sectional area
ASTM	-	American Standard Testing Material
EFB	-	Empty Fruit Bunch fibre
g	-	Gram
KFRP	-	Kenaf fibre reinforced polypropylene
K-PP	-	Kenaf fibre-Polypropylene
l	-	Length
L_f	-	Final gauge length
L_o	-	Original gauge length
MAPP	-	Maleated polypropylene
mm	-	Milimeter
MPa	-	Megapascals
P	-	Load
PP	-	Polypropylene
RIM	-	Reaction injection molding
SEM	-	Scanning electron microscopy
T_g	-	Glass-transition temperature
UTeM	-	University Technical Malaysia, Malacca
UTS	-	Ultimate Tensile Strength
W_f	-	Fibre weight
	-	Stress
e	-	Strain
$^{\circ}C$	-	Degree Celsius

REFERENCES

Ashby, Micheal F. (2011). "*Materials Selection in Mechanical Design*".4th Ed. United States: Elsevier Ltd.

Atefi, R., Razmavar, A., Teimoori, Farhad Teimoori, Farshad. (2012)."*Investigation on New Eco-Core Metal Matrix Composite Sandwich Structure*".Life Science Journal.

Callister, William D., Rethwisch, David G. (2011). "*Materials Science and Engineering*".8th Ed. Asia: John Wiley & Sons (Asia) Pte Ltd.

Everise Crimson (M) Sdn Bhd. "*What is Kenaf*". [Online].Available at:http://www.kenaf-everise.com.my/Kenaf_Everise/What_is_Kenaf.html (Accessed: 24 November 2012).

G. S. Upadhyaya. (1997)."*Powder Netallurgy Tehnology*". England: Cambridge International Science Publishing.

G. Taguchi. (1998)."*Introduction to Quality Engineering: Designing Quality into Product and Process*". Asian Productivity Organisation, Japan.

Granta's CES Edupack. (2007).Granta Material Intellingence. Granat Design Limited 2007.

Kalpakjian, Serope.,Schmid, Steven R.,Musa,Hamidon.(2010)."*Manufacturing Engineering and Technology*" (6th Ed).Singapore: Prentice Hall.

Matthews, F. L., Rawlings, R. D. (2000)."*Composite Materials: Engineering and Science*". USA: CRC Press LLC.

Noor Aliah Nordin.(2008). "*Design and Analysis of Sandwich Beam make by Combination of Kenaf Core and Bast*". Degree of Bachelor of Engineering (Honours) Manufacturing (Material Engineering), University Technical Malaysia Melaka (UTeM).

Onder, A.(2007). "*First Failure Pressure of Composite Pressure Vassels*".M.Sc Thesis, Graduate School of Natural and Applied Sciences of Dokuz Eylül University.

Polycomposite Sdn. Bhd.. [Online]. Available at: <http://www.polycomposite-sb.com> (Accessed: 20 May 2013).

Poly Group Inc. [Online]. Available at: <http://www.polygroupinc.com> (Accessed: 11 June 2013).

Richardson and Lokensgard.(1997)."*Industrial plastic theory and applications*". 3rd Ed.Singapore: Delmar Publisher Inc. pp. 143-146.

Saad, M. J. (2011)."*Effect of Maleated Polypropylene (MAPP) on the Tensile, Impact and Thickness Swelling Properties of Kenaf Core–Polypropylene Composites*". Journal of Science and Technology, 2(1).

CHAPTER 1

INTRODUCTION

Chapter 1 describes the introduction of the project. In this project, the effect of mixing ratio on the mechanical properties of polypropylene composite is studied. This chapter includes the background, problem statement, objectives and the scope of this project.

1.1 Background

Nowadays, various composites made from natural fibre are commercialized. The natural fibres are widely used as the reinforcement in making composites. The natural fibres have their advantages which they are low cost, lightweight, easy to find and high strength to weight ratio. Therefore, the demand of natural fiber in the manufacturing industry is increasing. It is because lack of sources and the increasing construction materials which based on mineral sources such as steel, aluminium and forest trees.

This project focuses on the effect of mixing ratio on the mechanical properties of polypropylene composites. The purpose of this project is to find out the mechanical properties of polypropylene composite and pure polypropylene using Tensile Test. Thus, the results obtained can be extracted and analyzed. Compounds of the polypropylene composites are mixed with different mixing ratio. Therefore, the effect of the mixing ratio on polypropylene composites can be identified clearly.

The materials used in this project were Polypropylene (PP) and Kenaf fibre. To ensure mixing ratios between kenaf fibre and PP are fully mixing, coupling agent Polypropylene-graft-maleic anhydride (MAPP) was used.

In this project, polypropylene composite sample mixed between Kenaf fibre-Polypropylene (K-PP) composites were employed. The polypropylene composite samples were prepared by hot press machine. The results obtained from the tensile test was compared with polypropylene composites and the pure polypropylene which the differences can be seen clearly.

1.2 Problem statements

The mixing ratio can affect the mechanical properties of composite. Thus, this project was carried out to study the effect of the mixing ratio on the mechanical properties of the polypropylene composite. Tensile test was carried out in order to obtain the mechanical properties of the polypropylene composite. The project has been carried out in the Polymer Laboratory which is in University Technical Malaysia Malacca (UTeM) at Durian Tunggal, Melaka. The laboratory is equipped with an mixer machine, hot press machine and sample cutter machine. For the tensile test, it was conducted at the Materials Laboratory which in UTeM. The materials laboratory is equipped with a Universal Testing machine to conduct the mechanical test.

1.3 Objectives

The aim of this project is to study the effect of mixing ratio on the mechanical properties of polypropylene composite. The main objectives are:

1. To prepare polypropylene composite samples that are different in mixing ratio.
2. To find out the mechanical properties of material using tensile test.
3. To compare on mechanical properties of polypropylene composite.
4. To compare on mechanical properties of pure polypropylene and polypropylene composite.

1.4 Scopes of the research

This project focuses on the effect of mixing ratio on the mechanical properties of polypropylene composites. In this project, only one natural fiber uses that is kenaf fibre. The machines that used in this project were hot press machine, blender, vibratory sieve-shaker machine, universal testing machine, mixer machine and sample cutter machine. Three ratios of the kenaf fibre-PP composite used were: 10%:90%, 30%:70% and 50%:50%. The polypropylene composite that is made in this project is kenaf fibre-polypropylene (K-PP). The mechanical properties that observed in this project was tensile test. The shape of the specimen is dog bone shape or so called dumbbell shape.

1.5 Organizational of the report

To keep close the aim and objectives of this study, this report is organized in five chapters as follows:

- Chapter 1 – provides background and gist of the study.
- Chapter 2 – presents literature review of composites, natural fibre and testing.
- Chapter 3 – gives information on materials, testing procedures that involve in the experiment.
- Chapter 4 – reports on the results and discussion of experimental works.
- Chapter 5 – summarize the results and discussion as well as conclusions of the case study.

CHAPTER 2

LITERATURE REVIEW

This section basically shows the analysis of relevant journal, book and testing standard to the case study purpose. In this chapter, it contains few sections which are introduction to engineering materials, composites, polymer, natural fibres, hot press machine and tensile test.

2.1 Engineering Materials

Ashby et al. (2011) state that the engineering materials can be classified into the six broad families as show in Figure 2.1. Six broad families of engineering materials are metals, polymers, elastomers, ceramics, glasses, and hybrids. The members of a family have certain features in common: similar properties, similar processing routes, and, often, similar applications. The hybrids are the combinations of two or more materials in predetermined configuration and scale. They combine the attractive properties of the other families of materials while avoiding some of their drawbacks.

The family of hybrids includes fibre and particulate composites, sandwich structures, lattice structures, foams, cables, and laminates: almost all the materials of nature – wood, bone, skin, and leaf – are hybrids. Fibre-reinforced composites are, of course, the most familiar. Most of those at present available to the engineer have a polymer matrix reinforced by fibres of glass, carbon, or Kevlar (an aramid). They are light, stiff, and strong, and can be tough.

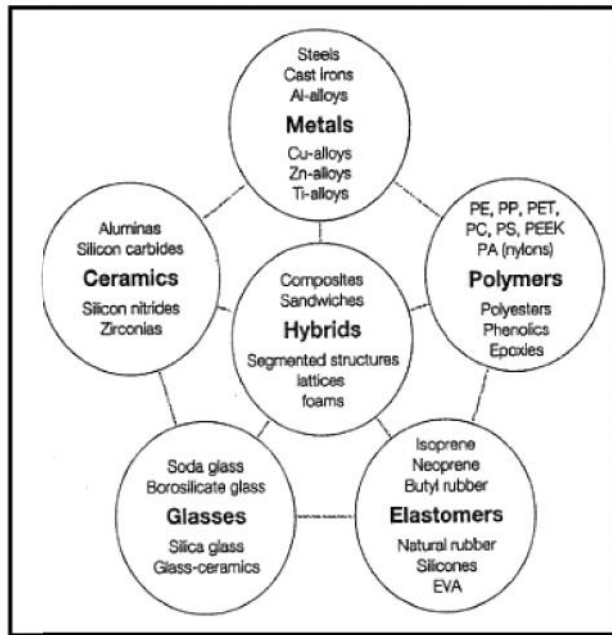


Figure 2.1: Figure classification of engineering materials (Ashby 2011).

According Ashby et al. (2011), it states that metals are stiff. They have relatively high elastic moduli. Most, when pure, are soft and easily deformed. They can be made strong by alloying and by mechanical and heat treatment, but they remain ductile, allowing them to be formed by deformation processes. Certain high-strength alloys (spring steel, for instance) have ductilities as low as 1%, but even this is enough to ensure that the material yields before it fractures and that fracture, when it occurs, is of a tough, ductile types. Partly because of their ductility, metals are prey to fatigue and of all the classes of material. They are the least resistant to corrosion.

Ceramics, too, have high moduli, but unlike metal, they are brittle. Their “strength” in tension means the brittle fracture strength; in compression it is the brittle crushing strength, which is about 15 times greater. And because ceramics have no ductility, they have a low tolerance for stress concentrations (like holes or cracks) or for high-contact stresses (at clamping point, for instance).

Glasses are noncrystalline (“amorphous”) solids. The most common are the soda – lime and borosilicate glasses familiar as bottle and ovenware, but they are many more. Metals, too, can be made noncrystalline by cooling them sufficiently quickly.