



Faculty of Mechanical Engineering

**THERMAL INSULATION MATERIAL MADE FROM
KENAF COMPOSITE**

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Bachelor of Mechanical Engineering

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DECLARATION

I declare that the project “Thermal insulation material made from kenaf composite” is the paperwork of my own work except for the cited stated in the references.

Signature :

Name :

Date :

DEDICATION

To my beloved mother, Puan Salinah Abas

And my beloved father, Encik Rofii Bin Hussein

APPROVAL

I hereby declared that I have read this report and in my suggestion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

Signature :

Supervisor's Name :

Date :

ABSTRACT

Malaysia is a hot-humid country that need a very good material to act as the thermal insulator for building. Previously, the material such as brick is use as the wall for the building. However, it lead to the thermal comfort issues to human. Due to that, the manufacturer company create a product that can solve the thermal comfort issue. A combination of polymer matrix and the natural fibre is designed and become a trending in the market. Kenaf is one of the natural fibre that are expected to be a good thermal insulator for the houses and buildings. However, the kenaf cannot be produce alone. Due to that the polymer matrix such as the polypropylene is applied to produce a good composite material. The kenaf composite is fabricated using the major machine such as the internal mixer, the crusher and the hot-press machine. The fibre ratio is divided into polypropylene and kenaf powder of 50:50, 60:40, 70:30, 80:20.

The fabrication process is divided into different fibre ratio of kenaf powder and the polypropylene. In this report, three test is conducted in order to investigate the quality of the kenaf composite to be used as a thermal insulator. The test are covering the mechanical and the thermal properties. The three test have been conducted are the thermal conductivity test, the water absorption test and the hardness test on the kenaf composite. The investigation on the three tests can give the best fibre ratio of the specimen that can perform as a good thermal insulator. For the thermal conductivity testing the best k value obtain is 9.74. While for the absorption testing, the preferred moisture content is 10.07%. For the hardness testing is highest at the 71.27. From the result, can be concluded that the best ratio that need to be used is the 50:50 fibre ratio.

The kenaf-polypropylene composite is suited for thermal insulation application in the building. As a conclusion, the kenaf-polypropylene composite is recommended as a good thermal insulator due to the low thermal conductivity value and environmental friendly.

ABSTRAK

Malaysia merupakan negara panas lembap yang memerlukan bahan yang bagus untuk bertindak sebagai penebat haba di dalam bangunan. Sebelum ini bahan seperti batu bata digunakan sebagai dinding untuk bangunan. Walaubagaimanapun, ianya menimbulkan masalah keselasan kepada manusia. Oleh itu, syarikat pengeluar telah mencipta sebuah produk yang boleh menyelesaikan isu kelesaan suhu ini. Gabungan bahan matrik polimer dan serat semulajadi telah dicipta dan semakin popular di dalam pasaran. Kenaf merupakan satu serat semulajadi yang dijangka boleh menjadi suhu penebat yang baik untuk perumahan dan bangunan. Tetapi, kenaf tidak boleh dihasilkan secara bersendirian. Disebabkan itu, kenaf perlu dicampurkan dengan matriks polypropylene (PP) untuk menghasilkan bahan komposit yang baik. Komposit Kenaf akan dihasilkan menggunakan mesin utama seperti campuran dalam mesin, mesin hancur dan mesin tekanan panas.

Penghasilan Kenaf akan dibahagikan kepada beberapa nisbah serbuk kenaf dan Polypropylene. Di dalam laporan ini, sebanyak tiga ujian akan diadakan untuk mengetahui kualiti kenaf komposit sebagai suhu penebat. Ujian tersebut akan merangkumi ujian mekanikal dan ujian suhu. Tiga ujian yang akan disediakan ialah ujian kekonduksian suhu, ujian penyerapan air dan ujian kekerasan bahan. Siasatan keatas ketiga-tiga ujian ini akan memberi solusi nisbah yang terbaik untuk dijadikan sebagai suhu penebat.

Sifat-sifat suhu penebat yang baik akan dikaitkan dengan ketiga-tiga ujian yang diadakan ini. Dengan membandingkan dengan bahan kajian yang lepas, analisis data boleh dilakukan dan nisbah Kenaf komposit yang terbaik akan dipilih sebagai suhu penebat.

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TABLE OF CONTENTS

	PAGE
DECLARATION	ii
DEDICATION	iii
APPROVAL	iv
ABSTRACT	v
ABSTRAK	vi
ACKNOWLEDGEMENTS	vii
TABLE OF CONTENTS	ix
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF APPENDICES	xiv
LIST OF ABBREVIATIONS	xv

CHAPTER

1. INTRODUCTION

1.1. Background Study	1
1.2. Problem Statement	2
1.3. Objective	4
1.4. Scope of Project	
1.4.1. Fabrication	4
1.4.2. Testing	5
1.4.3. Analysing Data	5
1.4.4. Comparison	5

2. LITERATURE REVIEW

2.1. Kenaf and Thermal Insulation	6
2.2. Thermal Conductivity (k)	8
2.3. Water Absorption	10
2.4. The hardness testing	11

3. METHODOLOGY

3.1. Introduction	14
3.2. Research and studies	16
3.3. Materials	
3.3.1. Kenaf and Polypropylene (PP)	17
3.4. Composite Preparation	
3.4.1. Internal mixture	19
3.4.2. Crusher machine	20
3.4.3. Hot-press machine	22
3.4.4. Product 1	25
3.5. Thermal Conductivity Test	26
3.6. Water Absorption Test	27
3.7. The Hardness testing	28

4. RESULTS AND DICUSSION	
Experiment Testing	
4.1. Thermal conductivity	30
4.2. Water Absorption testing	35
4.3. Hardness testing	40
5. CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH	48
REFERENCE	50
APPENDIX	54

LIST OF TABLES

TABLES	TITLE	PAGE
1.1	Fibre Ratio	4
4.1	WA testing 50:50	31
4.2	WA testing 60:40	31
4.3	WA testing 70:30	32
4.4	WA testing 80:20	32
4.5	Hardness testing 50:50	40
4.6	Hardness testing 60:40	41
4.7	Hardness testing 70:30	41
4.8	Hardness testing 80:20	42

LIST OF FIGURES

FIGURES	TITLE	PAGE
1.1	Kenaf Fibre	2
1.2	The building envelope	3
1.3	The building envelope entities	3
2.1	The thermal insulation	7
2.2	The effect of density and thermal conductivity	8
2.3	Heat flow meter schematic diagram	9
2.4	Hardness testing	12
3.1	Flow work	15
3.2	Kenaf powder	17
3.3	Polypropylene	18
3.4	Composite product	19
3.5	Internal Mixer Schematic Diagram	20
3.6	Crusher Schematic Diagram	21
3.7	crushing process	21
3.8	Granule composite material	22

3.9	20x10x0.3cm mold	22
3.10	Cylinder mold	23
3.11	Air bubble trap	23
3.12	Hole on mold	23
3.13	Mycut CNC plasma	24
3.14	Hot press machine schematic diagram	25
3.15	20x10x0.3 c product	25
3.16	Cylinder product	26
3.17	The setup of Infrared Lamp and Gun	27
3.18	Water Absorption testing	27
3.19	Schematic diagram beakers and dry oven	28
3.20	Hardness durometer testing	28
3.21	Schematic diagram durometer	29
4.1	Temperature changes 50:50	31
4.2	Temperature changes 60:40	31
4.3	Temperature changes 70:30	32
4.4	Temperature changes 80:20	32
4.5	Relationship thermal conductivity	33
4.6	Relationship immersion and weight change	37
4.7	Moisture content and different fibre ratio	39

4.8	Shore D hardness scale	43
4.9	Hardness strength of kenaf	43
4.10	Relationship density and fibre ratio	44
4.11	Comparison experiment and journal	44

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
1	Fabrication process	54
2	Thermal conductivity testing	55
3	Water Absorption testing	56
4	Hardness testing	56
5	Gantt chart	57

LIST OF ABBREVIATIONS

ABBREVIATION	TITLE	PAGE
PP	Polypropylene	4

LIST OF SYMBOLS

TABLES	TITLE	PAGE
K	Thermal conductivity	30
Q	Heat transfer	26

CHAPTER 1

INTRODUCTION

1.1 Background Study

Kenaf fibre is natural fibres that become more popular in the industry. It is highly demanded by many company. Many company demand for it due to its lightweight and environmentally sustainable materials (Siew *et al.* 2017). It is because Kenaf can give a lot of benefit compare to the exist material that has been used in construction. A few study is conduct to investigate the quality of Kenaf as a thermal insulator. Kenaf is a fibre plant native to the east Africa. Kenaf is discovered to replace the existence brick that has been used for the construction. To produce a solid Kenaf product, a few process need to be done. Kenaf will mix together with the Polypropylene according to the weightage percentage for each material.

The study on the Kenaf as the insulator are conduct due to its advantage in the construction field. From the journal stated that Kenaf can improving the mechanical strength. The addition of Kenaf in Polypropylene lead to the higher flexural strength. Kenaf also has high cellulose content and also has good micro fibrils orientation that can lead to the high flexural modulus.

By applying the Kenaf also can help to control the environmental issues. Kenaf is a fibre that very easy to control. It is because Kenaf has a short plantation cycle and the amount of pesticide requires are less (Siew *et al.* 2017). Temperature gives big influence in the thermal stability of the Kenaf (Siew *et al.* 2017). So, the temperature in the building can be consistence from day to night when Kenaf is used. For the study, a few test such as the thermal conductivity test and water absorption will be carry out in order to know the ability of the Kenaf as a thermal insulator.

This study is very important to our country because it can give benefit to us and also can help us in exporting the local product and make our economy become better.



Figure 1.1 :Kenaf fibre

1.2 Problem Statement

Malaysia is a country with tropical climate that sunny during day and cool during night. So, the heat from the sun radiation can give impact to the building in Malaysia. From year to year, many development had happened in terms of the thermal insulation. From one material to others. For now, mostly in building development, barrack or cement is used as the material.

Normally, the building thermal represent the energy consumption (Wang *et al* 2009). In order to save the building energy consumption for the comfort, the thermal performance of building envelope need to be improved (Wang *et al.* 2009). The four factors to get the thermal comfort are the envelope design, natural cooling sources, hybrid cooling system and adapting lifestyle.

The crucial factors that give effect to the envelope design is the climate (E.M. Okba ,2005). For the building envelope in Malaysia, during day, 70% of the sun radiation is absorbed by the ceiling and 30% are absorbed by the wall. The material used keep the absorbed heat until night. The problem occur when, at night, the heat will be released into the building. So, the room temperature will be increase higher. It lead to the people inside the building feel uncomfortable. Mostly, they will start using the air conditioner to feel more comfortable which is not good for our mother earth.

Materials that surrounds the building give crucial role as a protection. Good care must be taken when choosing the material for every parts in the building envelope (E.M Okba , 2005). Due to that, a non-woven material such as Kenaf that become popular lately

is suggested to be used as the material for the ceiling and wall for the building. It is because the Kenaf function better than the other material when it comes to the thermal insulation. Kenaf material will make people feel more comfortable at night because the percentage heat absorbed is less than usual.

So, three test have been conducted for the Kenaf on the thermal and mechanical properties to know the ability of Kenaf to be good material for themal insulator.

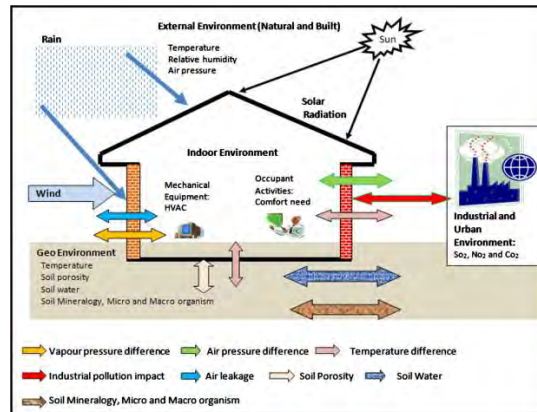


Figure 1.2 : The building envelope

The building envelope made up of structural materials such as walls, roofs, windows and doors (E.M Okba, 2005). The envelope is very important because it functioned to protect the indoor environment from any changes in weather from outdoor environment (Rivard *et al.* 1999). The building is made up of a few parts such as the envelope planes, envelope areas, envelope sections, envelope layers, openings, connections, and indoor (Rivard *et al* 1999).

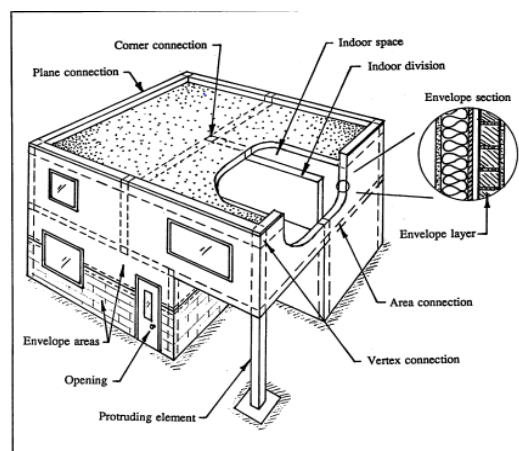


Figure 1.3 : The building envelope entities

1.3 Objective

For this study, we will be focus on three type of study. The three study will be focus on the thermal properties only. To be good as thermal insulator, Kenaf composite must be test to know the level of the quality. To make sure our experiment is success, four guidelines is set up as the objective. The objectives of this study are :

1. To determine out the thermal conductivity value (k) for Kenaf/PP composite.
2. To analyze the water absorption on the Kenaf/PP composite.
3. To investigate the hardness on the Kenaf/PP composite.
4. To compare the experimental with the findings from previous researchers

1.4 Scope of Project

In order to get a good and accurate results, there are a few scope that need to be focus on. For the project, we focus on the four scope that surely can give a good result for experiment that had been carried out. These procedure need to be followed to avoid wasting much time in doing the testing.

1.4.1 Fabrication

The first step that need to be done is fabricate the Kenaf fibre to be the suitable material for the experiment. The raw material which is the Kenaf fibre will be undergo a few experiment in order to get the exact material. As we know, Kenaf is a natural fibre is mixed with the polypropylene (pp) in a internal mixture in order to produce the Kenaf composite. There are different proportion of the Kenaf and PP mixture that need to be fabricate for every test. The amount of both mixtures are set to 100%. However, the percentage of the polypropylene must be higher or equal to Kenaf. Percentage of Kenaf cannot be higher than PP.

Table 1.1 : fibre ratio
Percentage Weightage

Kenaf	Polypropylene (PP)
20	80
30	70
40	60
50	50

1.4.2 Testing

Next scope will be focus on the test. Refer to the objective, three guidelines are stated in order to achieve a good result. Due to that, the test will be carry out using different method to investigate the quality of the Kenaf as a thermal insulator. The three test that will be carry out are the thermal conductivity test (k-value), the hardness test and also the water absorption test. The data from each experiment will be record as a references and comparison.

1.4.3 Analysing data

After the test are carried out, the data are used to be analyse. The data obtain can be as a benchmark for our test. For each test will give a different data and we can draw a few conclusion for it. The data act as the solid prove of the experiment that has been carried out. It need to analyse in order to call the experiment as a success or not.

1.4.4 Comparison

To get more accurate result, the data than has been obtained need to be compare with the theoretical value that we find from the journal and previous research. By comparing the data, we can know that the value that we get is correct and can be use officially. By comparing the result, we can also know whether Kenaf is a good thermal insulator or not.

CHAPTER 2

LITERATURE REVIEW

2.1 Kenaf and Thermal Insulation

In the modern life, the natural fibre such as Kenaf, banana and others have been used widely in order to control the thermal comfort and also the environment. Since years, in every technology aspect, environmental issue is a crucial issue (Lee *et al.* 2017). For this experiment, Polypropylene (PP) is mixed with the Kenaf fibre to be produced as a composite material. Kenaf and PP composite show better flexural properties compared to other natural fibre/PP composite. According to N. S. Suharty, this is due to the high number of cellulose content in the Kenaf fibre (Lee *et al.* 2017). Asumani *et al.* 2012 conducted a study on the chemical bonding and found out that the alkali-silane treatment to the composite causes the tensile and the flexural properties better than other composites (N I S Anuar *et al.* 2017).

Kenaf or *Hibiscus cannabinus L.*, originates from Africa and belongs to the Malvaceae family (X.H Loh *et al.* 2016). Kenaf is a crop that is full of benefits. It has a good ability in CO₂ absorption (X.H Loh *et al.* 2016). Kenaf has a short period of plantation cycle and it grows in a fast rate (S.S Chee *et al.* 2017). Kenaf also has a low cost which is really needed by all companies (Natsuno Nishimura *et al.* 2017). According to K.K. Chawla (2011), Kenaf does not give harm to human health.

The natural fibre has become highly demanded in almost every sector because the natural fibre composite has better specific properties compared to other synthetic (N I S Anuar *et al.* 2017). Besides the advantage in mechanical properties, Kenaf also has limited thermal stability which is good to act as a thermal insulator (X.H. Loh *et al.* 2016). Kenaf

also offer other benefit such as odourless, lifelong time, noise insulation and attractive (X.H Loh *et al* 2016). According to some published report in December 2015, annual growth rate (CAGR) of the natural fibre market increase by 8.2% from 2015 to 2020 (S.S Chee *et al.* 2017). However, S. S. Chee *et al* (2017) stated that Kenaf has its own weakness such as the interfacial bonding between hydrophilic fibres and hydrophobic polymer is weak. This is due to the hydrophilic nature of the fibre.

Recently, the natural fibres are high demanding compare to the synthetic fibres. It is because of its advantages in every aspect especially in the automotive field due to the thermal properties (V. G. Yachmenev *et al.* 2004). Besides that, Kenaf composite also act as a good thermal insulator compare to the glass and bricks. According to S. S.Chee *et al.* (2017), the temperature gives a big impact on the thermal stability of the Kenaf composite. Kenaf can act as a good thermal insulator when the thermal stability is constant.

Malaysia is a hot-humid country and the temperature in the day can exceed 30 degree celcius. F. S. Westphal *et al.* (2011) conduct a study on the use of thermal insulation in a building envelope. The data is collected through a computer simulation. From the data, the result show that for building that has low load densities, the building envelope gives big influence on the cooling energy consumption. F. S Westphal *et al.* (2011) also stated in his journal that, in a hot country, the heat absorb through conduction can be reduce by using the thermal insulation in the building envelope.

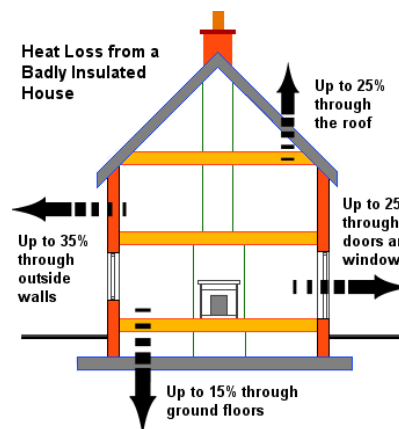


Figure 2.1 : The thermal insulation system (resource : lowenergyhouse.com)

2.2 Thermal Conductivity (k)

Thermal conductivity is to know the ability of the heat transfer for a specimen. There are method can study the relationship of the density and the thermal conductivity. From past studies show that the thermal conductivity is inversely proportional to the density. In the journal stated that during the process, the thermal conductivity is control the heat transfer rate by the bulk material. As notice, in the building, thermal properties such as the conductivity, the environmental performance and the energy performance is highlighted. From pervious study of Kiran et al and Mounika et al prove that there are strong relation between the fibre volume fraction and the conductivity. In this studies, natural fibre use is bamboo composite. For the testing, a hot disk thermal constants analyser is use to measure the conductivity (Darshil U Shah *et al.* 2016).

From Darshil U Shah et al (2016) journal also observe that in order to know the thermal conductivity, the specific heat capacity and the density must be known. From the hot disk measurement, the conductivity obtained is range from 0.20 to 0.35 W/m.K. by different type of coating, the hypothesis that the density of the material affected the thermal conductivity is valid. This is due to the changes in the proportion of the cell wall material. In figure , the result of different specimen can be observe. The graph show that different specimen give different k value.

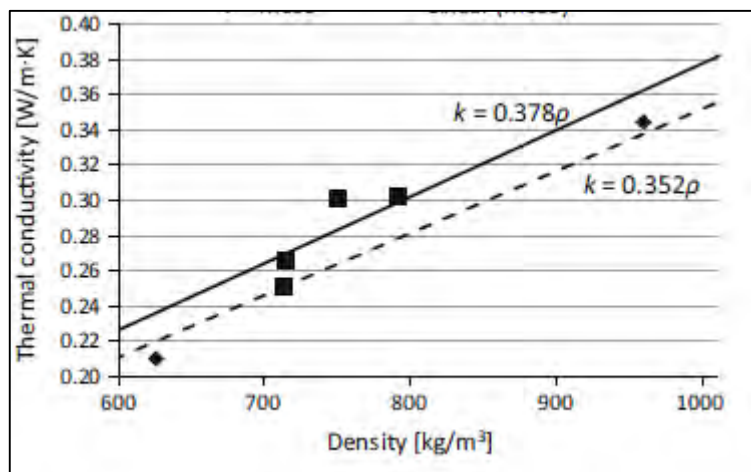


Figure 2.2 : The effect of density on conductivity.