

INSULATION MATERIALS FOR HOME RESIDENCE BUILDING WALL

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SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of degree of Bachelor of Mechanical Engineering (Thermal-Fluids)”

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**This report is submitted as partial requirement for the completion of the Bachelor of
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DECLARATION

I declare that this report entitle “Insulation Materials For Home Residence Building Wall” is the result of my own research except as cited in the references.

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DEDICATION

I dedicate this report to my father, Shammuin bin Mustapha, who taught me the true meaning of hard life and led me through the relentless challenges of this life. For my mother, Saadah binti Abdul Samad, I dedicate to her on her willingness to teach me that not all things seem hard and difficult thing is not necessarily impossible to reach. She taught me that experience is the teacher that is within every human conscience. To all my siblings, as willing to give lessons that they have been through in their succesful life, without you, this reports is meaningless, because the most expensive thing in the world is experience and worthwhile knowledge.

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ABSTRACT

The objective of this research is to evaluate the effectiveness of various types of insulation for the walls of the house as well as study the effect of different materials on how internal and external heat and cool homes. Insulating materials to be studied are polystyrene, fiberglass, wool and cotton. The third objective refers to the assessment to be carried out on the state of the insulation material by practicing the use of an infrared camera. The study will be conducted at reconfigurable house, made of cardboard. Model homes involved have a special space for the installation of insulation in the walls, roof and floor. Various parameters will be recorded by using infrared cameras and Thermogram implemented throughout research. Calculations will be made and the graph will be drawn to facilitate the detail and analysis on the results of the study implemented. Besides experiments, scientific research is also carried out to support the results of studies using previous studies as well as a variety of information available on the internet, books, articles, journals and other reference sources.

Keywords: Insulation materials; Infrared camera; Reconfigurable house

ABSTRAK

Objektif kajian ini adalah untuk menilai keberkesanan pelbagai jenis penebat untuk dinding rumah serta mengkaji kesan bahan-bahan yang berbeza pada haba bagaimana dalaman dan luaran dan rumah sejuk. Bahan penebat yang akan dikaji adalah polistirena, gentian kaca, bulu dan kapas. Objektif ketiga merujuk kepada penilaian yang akan dijalankan pada keadaan bahan penebat dengan mempraktikkan penggunaan kamera inframerah. Kajian akan dijalankan pada model rumah yang boleh dibentuk semula. Model rumah terbabit diperbuat daripada kadbod. Model rumah terlibat mempunyai ruangan khas untuk pemasangan penebat dalam dinding, bumbung dan lantai. Pelbagai parameter akan direkodkan dengan menggunakan kamera inframerah dan Termogram dilaksanakan sepanjang penyelidikan. Pengiraan akan dibuat dan graf akan dilukis untuk memudahkan perincian dan analisis ke atas hasil kajian. Selain eksperimen, penyelidikan ilmiah juga dijalankan untuk menyokong hasil kajian yang menggunakan kajian terdahulu serta pelbagai maklumat yang boleh didapati di internet, buku, artikel, jurnal dan sumber rujukan yang lain.

Kata kunci: Bahan penebat; Kamera Inframerah; Model rumah

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF SYMBOLS	xiv
	LIST OF APPENDICES	xv
CHAPTER 1	INTRODUCTION	1
	1.1 INTRODUCTION	1
	1.2 BACKGROUND	2
	1.3 PROBLEM STATEMENT	3
	1.4 OBJECTIVES OF STUDY	3
	1.5 SCOPE OF STUDY	4
	1.6 SIGNIFICANCE	4
CHAPTER 2	LITERATURE REVIEW	5
	2.1 HUMAN COMFORT	5
	2.2 INSULATION	7
	2.3 TYPES AND CATEGORIES OF INSULATION MATERIALS	8
	2.4 INSULATION MATERIALS SELECTION FACTORS	11
	2.4.1 R – VALUE	11
	2.4.2 U-VALUE	12
	2.4.3 THERMAL CONDUCTIVITY, λ	13
	2.4.4 THICKNESS AND COST	14
	2.5 WALLS AND INSTALLATION OF INSULATION MATERIALS	16

	2.5.1	TYPES OF WALLS	16
	2.5.2	INSULATION INSTALLATION	19
CHAPTER 3		METHODOLOGY	23
	3.1	INTRODUCTION	23
	3.2	INSULATION MATERIALS	23
	3.2.1	POLYSTYRENE	24
	3.2.2	FIBERGLASS	25
	3.2.3	WOOL	26
	3.2.4	COTTON	27
	3.2.5	CELLULOSE	28
	3.2.6	COCONUT COIR	29
	3.3	APPARATUS	30
	3.3.1	IR CAMERA (FLIR I5)	30
	3.3.2	RECONFIGURABLE HOUSE (MARCRAFT GT-7500)	32
	3.4	PROCEDURES (Warmke & Warmke, 2010)	35
	3.4.1	EVALUATING INSULATION BY USING AN IR CAMERA (FLIR I5) AND THERMOSTAT	36
CHAPTER 4		RESULT AND DISCUSSION	38
	4.0	INTRODUCTION	38
	4.1	METHOD 1	39
	4.1.1	HOUSE WITH NO HEAT SOURCE	39
	4.1.2	HOUSE WITH FAN AND BULBS SWITCHED ON	40
	4.1.3	HOUSE WITH ONLY FAN IS SWITCHED ON	44
	4.1.4	METHOD 1 OVERALL RESULTS	46
	4.1.5	HISTOGRAM COMPARISON OF METHOD 1 FOR 15TH MINUTES OF EXPERIMENT	48
	4.1.6	TEMPERATURE INCREMENT PERCENTAGE OF METHOD 1, HOUSE WITH FAN AND BULBS ARE SWITCHED ON	49
	4.2	METHOD 2	51
	4.2.1	HOUSE WITH NO HEAT SOURCE	51
	4.2.2	HOUSE WITH ONLY FAN IS SWITCHED ON	53
	4.2.3	HOUSE WITH FAN AND BULBS SWITCHED ON	55

4.2.4	METHOD 2 OVERALL RESULTS	59
4.2.5	HISTOGRAM COMPARISON OF METHOD 2 FOR 15TH MINUTES OF EXPERIMENT	60
4.2.6	TEMPERATURE INCREMENT PERCENTAGE OF METHOD 2, HOUSE WITH FAN AND BULBS ARE SWITCHED ON	61
4.3	METHOD COMPARISON	63
4.3.1	MATERIALS COMPARISON	63
4.3.2	CHANGES OF TEMPERATURE BY COMPARING BOTH METHOD WHEN ONLY FAN IS SWITCHED ON	70
CHAPTER 5	CONCLUSION AND RECOMMENDATION	73
5.1	CONCLUSION	73
5.2	RECOMMENDATION	74
	REFERENCES/BIBLIOGRAPHY	76
	APPENDICES	79

LIST OF TABLES

NO	TITLE	PAGE
2.1	Insulation materials. (Faculty of Electronic Engineering, 2005)	9
4.1	Results of Method 1, House with no heat source	39
4.2	Results of Method 1, House with fan and bulbs switch on	41
4.3	Images of Infra-red of Method 1, house with fan and bulbs switched on and its explanation	42
4.4	Results of Method 1, House with only fan is switched on	45
4.5	Temperature of 15th minute of Method 1	49
4.6	Temperature increment percentage of method 1, for house with fan and bulbs are switched on	50
4.7	Results for Method 2, house with no heat source	52
4.8	Results of Method 2, House with only fan is switched on	54
4.9	Results of Method 2, House with fan and bulbs switched on	56
4.10	Infra-red images of Method 2, House with fan and bulbs switched on and its explanation	57
4.11	Temperature of 15th minutes of Method 2	60
4.12	Temperature Increment Percentage of Method 2 for House with fan and bulbs are	62
4.13	Temperature changes of House with only fan is switched on at 15th minutes	71

LIST OF FIGURES

NO	TITLE	PAGE
2.1	Physiological reactions to body temperature. (Emery, 2011)	6
2.2	Classification of most used insulation materials. (Papadopoulos, 2004, p. 10)	9
2.3	Categorized by Department of Biosystems and Agricultural Engineering - University of Kentucky. (Department of Biosystems and Agricultural Engineering , 2009)	10
2.4	Apparent Thermal Conductivity vs Mean Temperature (Jeanne Baird, 2001)	14
2.5	Saving vs Thickness. (Mahlia, Taufiq, Ismail, & Masjuki, 2006)	15
2.6	Saving vs Thickness of insulation (Kayfeci, Kecebas, & Gedik, 2011)	15
2.7	Solid walls. (Heatex Group Ltd, 2011)	16
2.8	External and internal wall insulation comparison. (Changeworks (www.changeworks.org.uk), 2012)	17
2.9	Inner and outer leaf of cavity walls. (Heatex Group Ltd, 2011)	18
2.10	Loose-fill insulation. (Building Energy, Inc., 2011)	19
2.11	Batts installation is being done. (Virginia Department of Mines, Minerals and Energy.2006, p. 34)	20
2.12	Rigid foam installation is done by nailing. (Owens Corning inc., 2012)	21
2.13	Insulation material is being spray before it become rigid structure. (Virginia Department of Mines, Minerals and Energy., 2006, p. 35)	22
2.14	blow-in-blanket system is being used. (Virginia Department of Mines, Minerals and Energy., 2006, p. 35)	22
3.1	Polystyrene in rigid foam	24
3.2	Fibreglass Inserts in form of organic fibrous	25
3.3	Wool insulation in fibrous form	26
3.4	Cotton insulation	27
3.5	Cellulose insulation	28
3.6	Coco coir insulation	29
3.7	IR Camera (FLIR i5). (metrum)	30
3.8	Front view of Reconfigurable house	32
3.9	Side view of Reconfigurable House	32
3.10	Inside of the house, when front side of the house is removed	34
3.11	Front part of the house walls installed with Polystyrene insulation	35

installed polystyrene, rigid foam insulation	
3.12 Method 1 Process Chart	36
3.13 Method 2 Process Chart	36
4.1 Graph of Temperature vs. time for Method 1, House with no heat source	40
4.2 Graph of Temperature vs. time for Method 1, House with fan and bulbs is switched on	42
4.3 Graph of Temperature vs. time for Method 1, House with only fan is switched on	46
4.4 Graph of Temperature vs. time for overall Method 1 result	47
4.5 Histogram of Temperature of 15th minute for Method 1	49
4.6 Pie Chart of Temperature Increment Percentage for house with fan and bulbs are switched on	51
4.7 Graph of Temperature vs. Time for Method 2, House with no heat source	53
4.8 Graph of Temperature vs. Time for Method 2, House with only fan is switched on	55
4.9 Graph of Temperature vs. Time for Method 2, House with fan and bulbs switched on	57
4.10 Graph of Temperature vs. Time of Method 2 completely	59
4.11 Histogram of Temperature of 15th minute of Method 2	61
4.12 Pie chart of Temperature Increment of Method 2, House with fan and bulbs are switched on	63
4.13 Graph of Temperature vs. Time of No insulation	64
4.14 Graph of Temperature vs. Time of Polystyrene Insulation	65
4.15 Graph of Temperature vs. Time of Wool Insulation	66
4.16 Graph of Temperature vs. Time of Cotton insulation	67
4.17 Graph of Temperature vs. Time of Fibre glass insulation	68
4.18 Graph of Temperature vs. Time of Cellulose Insulation	69
4.19 Graph of Temperature vs. Time of Coco coir insulation	70
4.20 Histogram of temperature changes for house with fan and bulbs are switched on	72

LIST OF SYMBOLS

A = Area of insulation surface

L = Thickness of insulation material

λ = Thermal efficiency

ΔT = |internal temperature-external temperature|

U = U-value, conductivity value

R = R-value, resistance value

Q = Heat flows

LIST OF APPENDICES

NO	TITLE	PAGE
1	Flow chart of the research	80
2	Gantt chart of the research	81
3	Final Year Project 1 Poster Presentation	82
4	Final Year Project 2 Poster Presentation	83
5	Overall results of Method 1, External temperature of the house	84
6	Overall results of Method 2, External temperature of the house	86
7	IR images of the Research	88
8	IR images of the Research	89
9	IR images of the Research	90

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter gives an overview on wall insulation. The whole research is about wall insulation, specifically to find the best material to use in Malaysia, the country with climate of equatorial, being hot and humid throughout the year.

Wall insulation could be traced back in western countries from the 80's when the technology of wall insulation thickness was begun to develop. (Papadopoulos, 2004, p. 9). However, according to website eHow on home cavity wall, the Greeks and romans were the ones who first started to concern about the comfort in houses. Their wall houses were built by multiple vertical layers called *wythes* the technique were used to make sure there are air circulation to increase the comfort of the occupant. (Wilson, 2012).

Insulation in simple words is an act that preventing heat transfer. Nowadays, wall insulation is becoming very crucial for stabilizing the temperature of the house and helps maintaining the comfort zone. A handbook, *Thermal Insulation Materials* described as, insulation materials are specifically designed to decrease the temperature of a space by reduces the heat flow. (NETZSCH-Gerätebau GmbH,

2000). In Europe, according to Papadopoulos, insulation in the walls is dominated by two types of insulation which are fibrous organic material and organic material foam. (Papadopoulos, 2004)

1.2 BACKGROUND

In Malaysia, solid walls are the main type used for the walls of the house in Malaysia. While the walls of the house in Malaysia rarely insulated regardless of on the external or internal part of the wall. Therefore, warm in house might become a problem, thus should be solved with an efficient air distribution method that requires a lot of cost in the long run.

Insulation really helps in maintaining human comfort of the occupants of a residential house. Insulation may also cut cost in air conditioning and ventilation system of a house by reducing the use of energy for that system in order to achieve comfort. In order to achieve those desires, insulation by different type of materials is tested to find their effectiveness thus judging the best of them all.

Basically, by conducting a research on a scaled down house model as the setup of experiment, a number of parameters are measured and recorded. For example, inside and outside temperature of the reconfigurable house will be taken. **Figure 1** shows the reconfigurable house. Many aspects of insulation material have to be considered in order to find the best material to be used as insulation for Malaysian houses.

The research will be carried out to determine the best insulation material to be used in Malaysia. The work will be executed by using the apparatus. The temperature

of the house will be observed by using Infra-Red (IR) Camera (**Figure 2**) with different types of materials for wall insulation.

1.3 PROBLEM STATEMENT

For this study, the problem statements are as follows:

1. Malaysia is a country that is equatorial, hot and humid throughout the year. Hot and humid in house environment makes human feel uncomfortable. Besides, energy and cost for air conditioning is very high.
2. Conventional house wall does not prevent heat from outside transferred into house.

1.4 OBJECTIVES OF STUDY

1. To evaluate the effectiveness of various types of insulation for building wall.
2. To examine the effects of different materials on how the interior and exterior of the house heats and cools.
3. To evaluate the condition of installed insulation using the infra-red camera.

1.5 SCOPE OF STUDY

The scope of the study is that the area covered during the study undertaken. For this research, the scope only covered:

1. Experiments will be conducted in reconfigurable model house.
2. Materials of Insulations consist of polystyrene, fiberglass, wool, and cotton.

1.6 SIGNIFICANCE

Too many advantages can accrue from the study. The main objective is to identify the best material to be used as wall insulation for homes in Malaysia. Results of the study would affect the use of wall insulation in Malaysia. Various aspects and parameters will be measured to determine the level of comfort for the occupants of the house in Malaysia. Among these are the temperatures inside and outside the home model, the thickness of the material and may even cost for each material also influence the final outcome of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 HUMAN COMFORT

Comfort is a state of mind with the absence of discomfort for an individual. So, comfort level is different for each individual. This answers why in certain temperature, not all people would fell asleep easily at night. Factors that affect human comfort are (Emery, 2011):

- a. Temperature of the surrounding air
- b. Radiant temperatures of the surrounding surfaces
- c. Humidity of the air
- d. Air motion
- e. Odors
- f. Dust
- g. Aesthetics
- h. Acoustics
- i. Lighting

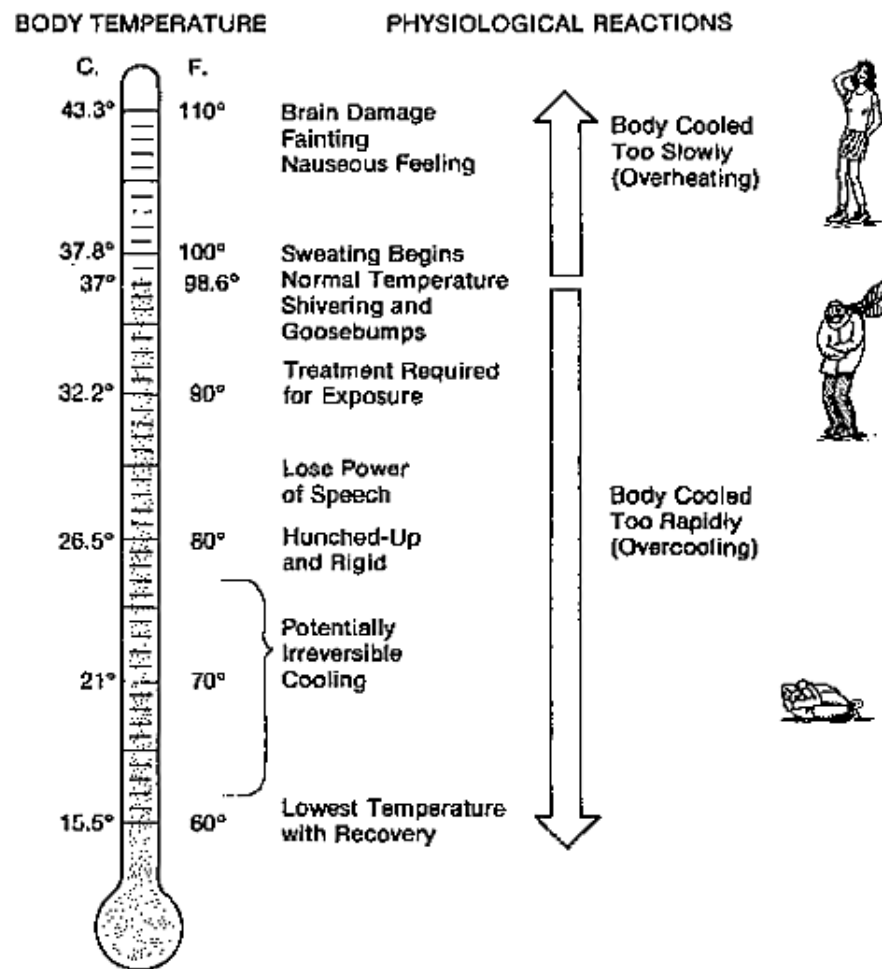


Figure 2.1 Physiological reactions to body temperature. (Emery, 2011)

Human comfort can be achieved by meeting all the comfort factor above. Each factor has a range of its own. If local conditions or the man involved in the relevant range, most likely he will be comfortable. For example, according to ASHRAE summer in United States, comfort level temperature is 20.6 °C to 22.8 °C. While relative humidity comfort level was 50% - 60%. (Jeanne Baird, 2001). Then, in order to achieve this, the man depending on what he is wearing, and the activities he is doing. Besides, air circulation of the place also plays an important role.

2.2 INSULATION

In simple language, insulation is an action that prevents something from entering the insulated area. Referring to the title of this research, the scope of the studies is thermal insulation made to home insulation so that the effectiveness of materials can be evaluated. Once again, simply said is that home wall insulation prevents heat transfers from occurring. (NETZSCH-Gerätebau GmbH, 2000). The reality is, no 100% prevention could be made, however, heat might be slows down to transfers as there are insulation at the wall of the house.

Due to its properties, insulation is very important in many aspects of life nowadays. As for Malaysia, a country that is equatorial, hot and humid throughout the year makes occupant of houses in Malaysia not so comfortable during the day. (Rilling, Siang, & Siang, 2006) Malaysian houses and building use air conditioners to cool the space in the house due to hot air outside the house and also to remove hot air from the house to outside. The house envelope is affected by three heat transfer methods which are conduction, convection and radiation. (Kayfeci, Kecebas, & Gedik, 2011) The heats are produced by occupants and appliances of the house. Since the occupants used the appliances all day long, energy consumption and cost for electricity would rise simultaneously. Therefore, according to T.M.I. Mahlia et al, a proper insulation material would help in decreasing the rate of outside heat from transfers into the house. Also, insulation materials would help absorb the heat produce by occupants and appliances. Thus, this will cut cost and also give comfort to the occupants. (Mahlia, Taufiq, Ismail, & Masjuki, 2006)

Houses that have high thermal efficiency could achieve higher temperature differences between its internal and external space temperature, and stabilize the difference for longer time. (Warmke & Warmke, 2010) All materials that have been used as insulator have its own insulation value and it is better known as R-value. (E. Giama, 2001) This will be discussed later in the factors affecting the effectiveness of insulation material.