INSULATION MATERIALS FOR HOME RESIDENCE BUILDING WALL

MOHAMMAD HAFIZUDDIN BIN SHAMMUIN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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)"

Signature : _____

Supervisor : Engr. Dr. Tee Boon Tuan

Date : _____

INSULATION MATERIALS FOR HOME RESIDENCE BUILDING WALL

MOHAMMAD HAFIZUDDIN BIN SHAMMUIN

This report is submitted as partial requirement for the completion of the Bachelor of Mechanical Engineering (Thermal Fluids) Degree Program

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

MAY 2013

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.

Signature	:	.....
Name	:	MOHAMMAD HAFIZUDDIN BIN SHAMMUIN
Date	:	

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.

ACKNOWLEDGEMENT

Alhamdulillah, thanks, to the Almighty Allah Most Gracious, Most Merciful for the blessing and grace, I managed to complete this report in a timely manner. Thanks are also due to be given up to my health through the days of this semester and this report properly completed.

Next I would like to thank my parents and my siblings who were willing to spend your precious time with me to help me prepare this report. Without the experience that you all pass and useful knowledge, it appears this report cannot be completed as well as worthless.

After that, I want to give my appreciation to the Prof. Dr. Md. Razali Bin Ayob, Dean of Faculty of Mechanical Engineering. Not forgetting, thanks to Mr Juffrizal bin Karjanto and Mr. Mohd Noor Asril bin Saadun which are also my panelist for Final Year Project because took the time to give guidance, suggestions, support and useful materials to me so I can properly experience Final Year Project 1 and also prepare this report. It appears all your expertise is precious to create a dedicated engineer.

Not to mention, special gratitude to all my friends whether under supervision of Dr. Tee Boon Tuan or the other colleques in UTeM who have helped me in various ways to help me completing the research during this semester and report writing.

I also want to give my deepest special appreciation to Engr. Dr. Tee Boon Tuan, my Final Year Project supervisor for his support and motivational words that pushed me stronger toward the end of this semester.

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

LIST OF TABLES

LIST OF FIGURES

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

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

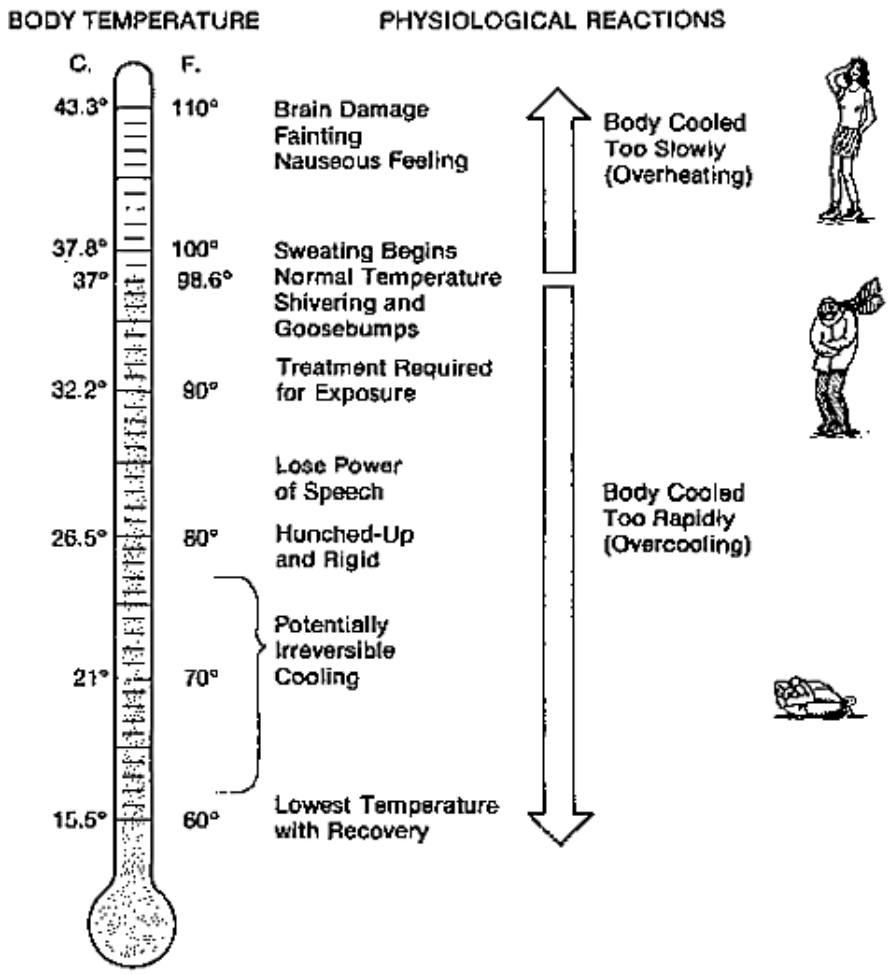

Figure 2.1 Physiological reactions to body temperature. (Emery, 2011)

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.