

A STUDY ON INSULATION MATERIAL  
OF ENERGY SAVING PURPOSES  
IN ROOFTOP DESIGN

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‘I/We\* hereby that I/We\* read this dissertation and found its content and form to meet acceptable presentation standards of scholarly work for the award of Bachelor of Mechanical Engineering (Thermal-Fluids) with honours’

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This dissertation is submitted as partial fulfilment of the requirement for the degree  
of Bachelor of Mechanical Engineering (Thermal Fluids)

Faculty of Mechanical Engineering  
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MAY 2010

## DECLARATION

I hereby, declare this project entitled “A study on insulation material of energy saving purposes in rooftop design” is the result of my own research except as cited in the reference.

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Date: 17 May 2010 .....

**DEDICATION**

*For my beloved family (Ayah and Emak), Usrah Khairani*

## **ACKNOWLEDGEMENT**

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## **ABSTRACT**

A study on insulation material in energy saving for rooftop design encompass to do an analyze and observation about thermal behavior, heat flux, temperature and all criteria involve that given rise the temperature inside household. To reduce energy consumptions in household is the goal of this project. Nowadays, heat is totally generated all over the world plus with the global warming make heat rise without boundary. When temperature rise in house or building especially for home or office, the best way to reduce the hot temperatures is by spend the electrical energy to get cool. There is has a lot of energy that use makes mankind spends on money and for long term this is not practical. Through this thesis the reduction of heat flow through insulation material can be seen by setup an experiment and proven the heat is reduce when exert the insulation material. After get the temperatures differences data the heat flow through rooftop can be analyze. Fluent is the tool to simulate the temperature and compute the heat transfer. As the theory is been proven all justification can be made with the result and study were end.

## ABSTRAK

*Kajian tentang bahan penebat haba untuk tujuan penjimatan tenaga bagi reka bentuk bumbung merangkumi kerja seperti analisis dan memerhatikan berkenaan keadaan haba sekeliling, termal fluks, suhu dan apa – apa criteria terlibat dalam menjadikan suhu di dalam rumah bertambah. Tujuan utama kajian dilakukan adalah untuk mengurangkan penggunaan tenaga di dalam rumah. Dewasa ini, kesan haba di seluruh dunia dapat di rasai dengan pemanasan global menambah kesan yang tidak terbandung. Apabila suhu bertambah di dalam rumah ataupun pejabat, kebiasaannya penggunaan tenaga elektik adalah opsiyen untuk sejukkan ruang. Penggunaan tenaga seperti itu, menjadikan pengguna terpaksa keluar wang untuk bil yang tinggi dan untuk jangka masa yang lama ini sungguh tidak praktikal. Melalui kajian ini pengurangan haba yang melalui penebat amatlah penting dan membuktikannya adalah melalui eksperimen. Pengiraan dan analisis adalah satu kaedah dalam kajian. Untuk melihat simulasi haba, perisian CFD adalah kaedah yang digunakan. Sebaik sahaja pembuktian berhasil kajian in berakhir.*



## CONTENT

CHAPTER	ITEM	PAGE
	<b>DECLARATION</b>	ii
	<b>DEDICATION</b>	iii
	<b>ACKNOWLEDGEMENT</b>	iv
	<b>ABSTRACT</b>	v
	<b>ABSTRAK</b>	vi
	<b>CONTENT</b>	vii
	<b>LIST OF FIGURE</b>	x
	<b>LIST OF TABLE</b>	xv
	<b>LIST OF SYMBOL</b>	xvi
	<b>LIST OF APPENDIX</b>	xvii
<b>CHAPTER I</b>	<b>INTRODUCTION</b>	1
	1.1 Project background	1
	1.2 Problem Statement	2
	1.3 Objectives of the Study	2
	1.4 Scope of study	3
	1.5 Project important	3
	1.6 Project briefing	3
<b>CHAPTER II</b>	<b>LITERATURE REVIEW</b>	4
	2.1 Introduction	4
	2.2 Conduction	5
	2.3 Thermal conductivity	7
	2.4 Convection	9
	2.5 Radiation	10
	2.6 Reducing Heat transfer through surfaces : Thermal Insulation	12

2.7 Reason for insulating	14
2.8 Rock wool	16
2.9 Benefits of low energy buildings	17
2.10 Why save energy	18
2.11 Low energy buildings	19
2.12 Roof constructions	23
2.13 Testing heat insulators (ASTM 2000)	25
2.14 Test method overview	25
2.15 Computational Fluid dynamics (Fluent) in modelling heat transfer	26
2.15.1 Rosseland radiation model theory	26
<b>CHAPTER III METHODOLOGY</b>	<b>27</b>
3.1 Introduction	27
3.2 Literature review	27
3.3 Methodology	27
3.4 Experimental on rooftop with and without insulation material	33
3.4.1 Objective	33
3.4.2 Apparatus	33
3.5 CFD simulation using Fluent & Gambit	36
<b>CHAPTER IV RESULTS</b>	<b>45</b>
4.1 Result of experiment of heat transfer through rooftop without insulation	45
4.2 Result of experiment of heat transfer through rooftop with 25 mm insulation	59
4.3 Result of rooftop without insulation material with Fluent (CFD)	77
4.4 Result of rooftop use rock wool insulation with Fluent (CFD) software	80
<b>CHAPTER V DISCUSSION</b>	<b>83</b>
5.1 Discussion about temperature taken	83
5.2 Discussion on heat flow between two experiments	85
5.3 Discussion from simulation Fluent	92
5.4 Comparison between experiment and fluent simulation	95

<b>CHAPTER VI</b>	<b>CONCLUSION AND RECCOMENDATIONS</b>	96
	<b>REFERENCES</b>	97
	<b>BIBLIOGRAPHY</b>	98
	<b>APPENDIX</b>	99



## LIST OF TABLE

<b>NO</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Thermal conductivities of some materials at room temperature (Source: Cengel, Y.A, 2003)	8
2.2	Typical value of convection heat transfer coefficient (Source: Bejan, A, 2003)	10
2.3	Emissivity's of some materials at 300K (Source: Cengel, Y.A, 2003)	11
4.1	Temperature taken at rooftop without insulation	46
4.2	Calculation of heat flow to 1 piece of rooftop	51
4.3	Table show the calculation of heat transfer to 1 piece ridge	53
4.4	Temperature taken at roof top with 25 mm rock wool insulation thickness	59
4.5	Result of heat flow calculation at right roof	63
4.6	Result of heat flow calculation at left roof	65
4.7	Result of heat flow calculation at ridge with insulation	70
4.8	Total heat flow among two experiments (W)	74
5.1	Comparison between experiment and simulation	95

**LIST OF SYMBOL**

A	=	Surface area, m <sup>2</sup>
E,U	=	Energy, KJ
Cal	=	caloric 4.1866 J
Btu	=	British thermal unit
$\dot{Q}$	=	heat transfer coefficient, (W/m <sup>2</sup> )
$\epsilon$	=	reflective surface
R-value	=	thermal resistance
$\alpha$	=	absorptivity
Q	=	heat flow (W)
C	=	degree centigrade

**LIST OF APPENDIX**

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
A	Conversions factor	99
B	Heat Flux	100
C	English to metric units	100
D	Heat transfer coefficient	101
E	Viscosity	101
F	Thermal conductivity	101
G	Structural and insulating materials	102
H	Structural building materials	103

## CHAPTER I

### INTRODUCTION

This chapter explain introduction to this general topic. The explanation encompasses every aspect in thesis such as project background, importance of project, objective, scope and projects briefing.

#### **1.1 Project back ground**

Nowadays, energy is very important due its application to entire world. Through physics the conservation of energy principle that state energy cannot be created or destroyed during a process; it can only change from one form to another. Energy can exists in numerous forms such as thermal, mechanical, kinetic, potential, electric, magnetic, chemical, and nuclear, and their sum constitutes the total energy  $E$  of a system. Energy can cross the boundary of a closed system in two distinct forms: heat and work. Most of energy from heat is coming from the sun and heat can transfer with 3 ways: conduction, convection and radiation. Base on this statement heat is transfer around world so any household in entire world were face the heat on day light. Every single heat that absorbed by roof or any part house can make that house turn to hot, it's required to minimize the heat using fan or air cond. Energy saving is the main purposes to stabilize the energy consumption in every household. To do this one method that has been used is to insulate the roof top. In this study the suggestion material is the rock



wool. Rock wool insulation is a mineral inorganic fibrous material with excellent and distinguished properties and characteristics. It is efficiently applied in all fields of thermo-acoustic insulation furthermore it is used in many industries and agricultural. Rock wool is produced by melting mix of basalt, limestone, & coke in a special vertical furnace at very high temperature (about  $1500^{\circ}\text{C}$ ). Then the molten rock is made in to thin fibers through a high speed centrifugal machine. After adding certain amount of binder, dustproof oil, silicon oil and mechanical operations, rock wool fiber then processed to be the final desired product with specified physical and chemical properties and specifications. The binder is sprayed equally by using new technology, so the rock wool fiber and binder can be tied in perfectly; avoid delaminating which happens often on rock wools produced by small production line. Rock wool is produce by automatic production line; the quality is much more stable and uniform. By adding more insulation to a wall or to the attic always decreases heat transfer. The thicker the insulation, the lower of the heat transfer rate. This is expected, since the heat transfer area  $A$  is constant, and adding insulation always increases the thermal resistance of the wall without increasing the convection resistance. Insulation makes good economic sense as it can reduce energy consumptions in buildings. Reduced energy consumption also becomes the benefit to the environment.

## **1.2 Problem Statement**

Energy consumption is very high during the mid day. Heat that transfers to the house can increase the temperature inside it. The most efficient strategy of energy saving in buildings is optimization of heat insulation. Thermal insulation can change the condition for a low heating energy demand.

## **1.3 Objectives of the Study**

- a) To understand the working principles, standard & theories through a literature study

- b) To study the Rock wool insulation and its effect in providing the thermal insulation to house
- c) To build roof model using ceramic rooftop and Rock wool insulation is blanket beneath the roof
- d) Setup an experiment on rooftop without Rock wool insulation and rooftop with insulation using the Data logger and simulate result use Fluent software

#### **1.4 Scope of study**

- a) To study only Rock wool insulation and its effect to provide the thermal insulation
- b) To construct the model for rooftop design
- c) The experiment is referring the standard test method (ASTM 2000) that is known as standard testing for insulator
- d) Final justification and conclusion

#### **1.5 Project important**

Global warming is the biggest problem for now. Temperature in any building is increase dramatically. This situation made more energy consumption during day. Study on the insulation for energy saving purposes is the low cost project differs than upgrade the air conditioning system or upgrade house ventilation.

#### **1.6 Project briefing**

This project study tells about the insulation material that was used on roof top design. Selection of insulation material is rock wool. The idea is to blanket the rock wool at the bottom of the ceramic roof. Several criteria must be considered such as to recognize temperature, heat loss and any aspect relate to heat transfer and energy saving purposes.









## CHAPTER II

### LITERATURE REVIEW

Literature consist the previous study or note that found from journals, book or internet that include literature about this study; insulation material, heat transfer, roof top and others.

#### 2.1 Introduction

The most efficient strategy of energy saving in buildings or household is optimization of heat insulation. The insulation material is use for cooling the house that will be placed at the outside house. Thermal insulation reduces the heat losses due to transmission and it is therefore the condition for a low heating energy demand. The extra insulation can be added from the outside or the inside. Both will have different consequences, e.g. insulation on the outside will change the appearance of the building facade, and insulation on the inside will decrease the living area. In addition, with internal insulation, care must be taken to avoid the risk of condensation in the other building envelope. Insulating the roof is a very important measure, which should be given special attention in every building. As warm air goes up, the temperature in the upper air layers of heated rooms is always a bit higher. That is the reason why a lot of heat can be lost through roof. During day light minimization of solar loads through a building envelope is primordial. According (Abdessalam *et al.* 1998) sixty percent of thermal transfer occurs in the roof. Thermal insulation of this component is of the upmost importance. Materials frequently used in for building insulation are chosen for their low thermal

conductivity and their ability to block the conductive heat flux. Materials having high reflectance are also used. They are made of aluminium foil combined with different layers of thin materials and are called radiant barriers. They cannot be characterized by a thermal resistance. According their study (Soubbdhan *et al.* 2003) the radiant barrier has received increased attention during the past years because of their ability to reflect the infrared radiation. They are commonly used in attics to reduce the radiant heat transfer that occurs between the roof deck and attics floor of a residence or commercial buildings. In an attic, the radiant barriers can be located on top of ceiling insulation or underneath rafters. These products, placed in attic, are a well documented means to reduce heat transfer through the ceiling. In Guadeloupian building the insulation material is placed in the roof airspace, between the corrugated iron roof top and the roof deck. Polystyrene and fibre glass are mostly used. Radiant barriers have been used for a few years, in the above described configuration. Indeed the roof airspace is only 4.5 cm, and the dust accumulation may be important, particularly in tropical humid climate.

## **2.2 Conduction**

Conduction is the transfer of energy from the more energetic particles of a substance to the adjacent less energetic ones as a result of interactions between the particles (Cengel, 2003). Conduction can take place in solids, liquids, or gases. The rate of conduction through a medium depends on the geometry of the medium, its thickness, and the material of the medium, as well as the temperature difference across the medium. When wrapping a hot water tank with glass wool (an insulating material) reduce the rate of heat loss from the tank. The thicker of insulation can overcome the smaller heat loss. It's also known that a hot water tank will lose heat at higher rate when the temperature of the room housing the tank is lowered. The larger the tank it is considers larger surface area and thus the rate of heat loss also.