UNIVERSITI PUTRA MALAYSIA

THERMAL EVALUATION AND SIMULATION OF GLASS WOOL/MAEROGEL® BLANKET

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THERMAL EVALUATION AND SIMULATION OF GLASS WOOL/MAEROGEL® BLANKET

By

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Thesis Submitted To the School of Graduate Studies, Universiti Putra Malaysia, in fulfillment of the requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in Fulfillment of the requirement for the degree of Master of Science

THERMAL EVALUATION AND SIMULATION OF GLASS WOOL/MAEROGEL® BLANKET

By

BAHADOR DASTORIAN JAMNANI

June 2014

Chairman: Mohd Roshdi Hassan, PhD
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Aerogel blankets are composites of silica aerogel particles dispersed in a reinforcing fiber matrix that turns the brittle aerogel into a durable and flexible insulating mat. While aerogel blanket manufacture from either organic or inorganic material, they are still some concerns over current environmental issues which are common worldwide are global warming, greenhouse effect, and climate change. Awareness of this environmental concern has led to the rise in an effort to renew agricultural waste like RHA (rice husk ash) which is cheaper precursor or a simple method in ambient pressure. As part of this study, to produce an insulator; glass wool was modified by ambient pressure drying methods to fabricate the flexible aerogel blanket. In order to evaluate thermal resistance of aerogel blanket, a hot plate is used. The microstructure of these aerogel blankets are also investigated for better understanding of the production process. Knowledge of the thermo-mechanical properties is important for the optimization of the design for these heterogeneouse materials. In order to assess the aerogel blanket, some technics such as thermal gravimetric analysis (TGA), scanning electron microscopic (SEM) and Fourier Transform Infrared spectrum (FTIR) was done. Moreover a simple numerical micro model have been developed to predict the effective thermal conductivity of flexible aerogel blankets, which consist of fibers, aerogel particles and air-pockets. This simulation has two parts. In the first part of simulation, the effective thermal conductivity of the aerogel composites is computed with different aerogel particles and different volume ratios using the finite element method. The numerical analysis of thermal conductivity is conducted by generating 3D models of the microstructure of the aerogel blanket. In the second part of model, the extracted result from the micro model is inputted to the real sized model to predict top surface temperature. Finally all experiment data are validated by a numerical real sized model.

In this study, a flexible aerogel blanket shows very good thermal resistance compare to original glass wool which is around 35% improvement. In addition TGA reveals that Maerogel® can retard material decomposition of blanket from 270°C to 287°C. Moreover SEM and FTIR clearly show that there is a good bonding between SiO₂
particles that make a strong network to tolerate high temperature and to be flexible blanket. Furthermore Maerogel® blanket structurally was simulated then was validated by experiment result that showed good agreement; there is a well matching between the data that were extracted from simulation and experiment.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENILAIAN TERMA DAN SIMULASI GLASS WOOL / MAEROGEL® SELIMUT

Oleh

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hubungan baik antara zarah SiO2 yang membuat rangkaian yang kaku untuk berubah dengan suhu yang tinggi dan menjadi selimut yang fleksibel. Disamping itu, struktur selimut Maerogel® telah disimulasikan dan kemudian telah disahkan oleh hasil eksperimen yang menunjukkan perasamaan yang baik; ada juga yang hampir sama antara data yang dipetik daripada simulasi dan eksperimen.
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At last but not least, I would like to dedicate this thesis to my daughter Diana. You will always be the source of my inspiration and a part of me.
I certify that a Thesis Examination Committee has met on 24 June 2014 to conduct the final examination of Bahador Dastorian Jamnani on his thesis entitled "Thermal Evaluation and Simulation of Glass Wool/Maerogel® Blanket" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>i</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>v</td>
</tr>
<tr>
<td>APPROVAL</td>
<td>vi</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xv</td>
</tr>
</tbody>
</table>

## CHAPTER

### 1. INTRODUCTION

1.1 Background
1.2 Problem Statement
1.3 Objectives
1.4 Scope of work
1.5 Overview

### 2. LITERATURE REVIEW

2.1 Introduction to Glass Fiber:
   2.1.1 Fiber Forming Processes
   2.1.2 GlassWool
2.2 Introductions to Sol-Gel
   2.2.1 Hydrolysis and Condensation Reactions
2.3 Manufacturing of Aerogel
   2.3.1 Gel Preparation
   2.3.2 Preparation of Silica Sol from RHA
   2.3.3 Aging of The Gel
   2.3.4 Drying of the Gel
2.4 Flexible Aerogel Blanket Fabrication
2.5 Introduction of Thermal Characterization
2.6 Thermal Properties of Flexible Aerogel Blanket
   2.6.1 Thermal Conductivity of Aerogel
   2.6.2 Thermal Conductivity of an Aerogel Blanket
2.7 Finite Element Analysis
   2.7.1 Introduction to ANSYS
   2.7.2 Finite Element Model

### 3. MATERIALS AND METHODS

3.1 Introduction
3.2 Chemical Procedures
   3.2.1 Preparation of Silica Maerogel® Blanket
3.3 Characterizations
   3.3.1 Thermo Gravimetric Analyzer (TGA & DTG) 27
   3.3.2 Scanning Electron Microscopy (SEM) 27
   3.3.3 Measurement of Thermal Resistance 28
   3.3.4 Fourier Transforms Infrared Spectra (FTIR) 30
3.4 Numerical Modeling Using Input from Experimental Observations 31
   3.4.1 Finite Element Modeling 33
   3.4.2 Finite Element Analyzing 34
   3.4.3 Finite Element Formulations 38
   3.4.4 Initial and Boundary Conditions 39
   3.4.5 Mesh Design 42

4. RESULTS AND DISCUSSION 44
4.1 Introduction 44
4.2 Characterization Method 44
   4.2.1 TGA&DTG (Thermogravimetric Analysis) 44
   4.2.2 SEM (Scanning Electron Microscopy) 50
   4.2.3 Thermal Resistant Results & Discussion 54
   4.2.4 FTIR (Fourier Transform Infrared Spectroscopy) 56
4.3 Result Validation 62
   4.3.1 Top Surface Temperature 62
   4.3.2 Validation Result for OGW (Original Glasswool) 63
   4.3.3 Validation Result for MGW (Modified Glasswool), Case4 64
4.4 Numerical Results & Discussion 65
   4.4.1 Thermal Conductivity (K) of the Real Sized Sample 65

5. CONCLUSIONS AND RECOMMENDATIONS 69
5.1 Conclusions 69
5.2 Recommendations 70

REFERENCES 71
APPENDIX 76
BIODATA OF STUDENT 83
LIST OF PUBLICATIONS 84