AN EVALUATION OF VOLTAGE GENERATION AND THERMAL DISTRIBUTION FROM ROAD PAVEMENT USING THERMOELECTRIC TECHNOLOGY

NURUL FADHILAH BINTI KAMARUDDIN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN EVALUATION OF VOLTAGE GENERATION AND THERMAL DISTRIBUTION FROM ROAD PAVEMENT USING THERMOELECTRIC TECHNOLOGY

NURUL FADHILAH BINTI KAMARUDDIN

This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

2018

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : An Evaluation Of Voltage Generation And Thermal Distribution From Road Pavement Using Thermoelecric Technology

Sesi Pengajian : 2017/2018

Saya NURUL FADHILAH BINTI KAMARUDDIN mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐ **SULIT*** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **TERHAD*** (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☐ **TIDAK TERHAD**

Disahkan oleh:

(TANDATANGAN PENULIS) (COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: Plot 186, Kg. Tersusun Tawas Tambahan 30010 Ipoh, Perak

Tarikh : 1 JUN 2018 Tarikh : 1 JUN 2018

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this report entitled "An Evaluation Of Voltage Generation And Thermal Distribution From Road Pavement Using Thermoelectric Technology" is the result of my own work except for quotes as cited in the references.

Signature : ……

Author : NURUL FADHILAH BINTI KAMARUDDIN

Date : 1st JUNE 2018

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : ……

Supervisor Name : DR AZDIANA BINTI MD YUSOP

Date : 1st JUNE 2018

DEDICATION

For my lovely mom and dad

ABSTRACT

This study is conducted to analyse the voltage generation and thermal distribution from road pavement based on thermoelectric technology. The characteristics of temperature difference between the pavement and ambient air, as well as the temperature gradient within road surface will be also investigated by collecting data on-site in different conditions; different weather conditions, different vehicle loads and gases released from the exhaust of the vehicle. The analysis of these behaviours is made possible by developing a set of road thermoelectric generator system. This road thermoelectric generator system can generate electricity when there is temperature difference between the pavement and ambient air. Instead of that, difference types of thermoelectric generators (TEGs) are also used to investigate the temperature difference. Apart from that, the low efficiency of power generation in thermoelectric generator which relies on the temperature gradients within pavement structure also will be improved in this study. In this study, car had the highest output voltage than motorcycle which is 1.3 V, 1 V and 0.0065 V in windy, cloudy and sunny day respectively.

ABSTRAK

Kajian ini dijalankan untuk menganalisis pembentukan voltan dan pengagihan haba dari turapan jalan berdasarkan teknologi termoelektrik. Ciri-ciri perbezaan suhu antara turapan dan udara ambien, serta kecerunan suhu dalam permukaan jalan juga akan disiasat dengan mengumpul data di lokasi dalam keadaan yang berbeza; keadaan cuaca yang berbeza, beban kenderaan yang berbeza dan gas yang dikeluarkan dari ekzos kenderaan. Analisis tingkah laku ini dimungkinkan dengan membangun satu set sistem penjana thermoelectric jalan. Sistem penjana termoelektrik jalan ini boleh menjana elektrik apabila terdapat perbezaan suhu antara turapan dan udara ambien. Daripada itu, perbezaan jenis penjana termoelektrik (TEG) juga digunakan untuk menyiasat perbezaan suhu. Selain itu, kecekapan rendah penjanaan kuasa dalam penjana termoelektrik yang bergantung kepada kecerunan suhu dalam struktur perkerapan juga akan dipertingkatkan dalam kajian ini. Dalam kajian ini, kereta mempunyai voltan keluaran tertinggi daripada motosikal iaitu 1.3 V, 1 V dan 0.0065 V bagi setiap waktu berangin, mendung dan panas.

ACKNOWLEDGEMENTS

First of all, I thank Allah Almighty for giving me the motivation, inspiration, patience, time and strength to complete this final year project excellently. With Allah's will and mercy, I have been able to achieve all of this.

This report also is the result of the collective efforts of a number of important and valued people who directly or indirectly assisted or supported me during my final year project period. I owe my gratitude and thanks to these people for always keeping supporting me without fail.

I would also like to express my deep and sincere appreciation and thankfulness to my supervisor, Dr. Azdiana Binti Md Yusop for her valuable guidance, advice and cooperation. I am totally do not manage to complete this project well without her endlessly guidance and advice.

Besides, I also would like to express my thanks to my lovely parents Kamaruddin Bin Mohammed Saad and Nor Izah Binti Nazri, family members and friends for their boosting and spiritual moral support, knowledge and how-to

throughout this whole final year. I had gain a lot of knowledge, valuable experiences and I had learned so much for it. Thank you.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF EQUATIONS

LIST OF SYMBOLS AND ABBREVIATIONS

C	:	Celsius
Kelvin	:	Kelvin
k	:	Kilo
m	:	Mili
s	:	Second
TEC	:	Thermoelectric Cooler
TEG	:	Thermoelectric Generator
TEM	:	Thermoelectric Module
USB	:	Universal Serial Bus
V	:	Volt
W	:	Watt
ZT	:	Figure-of-Merit

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter shall explain in details regarding this study as well as the root factors of why it is conducted. Besides that, all the scope of works and general methodologies taken toward completing this study are also explained briefly in this chapter.

1.1 Introduction

Energy harvesting is the process in which energy is captured from a system's environment and exploit the unused and deplete them. Then, they will change into useable electric power. Kinetic energy, solar, wind or strain are the example of energy that can be exploited. Moreover, some of the major sources that have a higher possibility for being harvested are thermal energy due to temperature gradient and

ambient air. So, asphalt pavement is one of the naturally occurring energy source. This is because asphalt pavement has received a lot of daily solar radiation and continuously exposed to vehicle loads. Then, this solar energy will dissipate as thermal energy in the inner structure of the pavement as well as the vehicle loads.

Specific technologies that can be used to extract energy from both of them and transformed them into electrical energy. Hence, thermoelectric generators (TEGs) are used to convert thermal energy to electricity. A set of road thermoelectric generator system is developed in order to evaluate the voltage generation and thermal distribution of road pavement. From, a previous study, it is found that the output voltage generated during hot day is higher than the output voltage generated during the cold day. So, the study is proven again and other conditions also will be investigated to achieve the objectives of this study.

Next, three sets of TEGs and heatsink are used to carried out this study. The characteristic of temperature difference between the pavement and ambient air as well as the temperature gradient within road surface are analysed by applying different conditions and ran through different time in a same day. Apart from that, the low efficiency of power generation in thermoelectric generator which relies on the temperature gradients within pavement structure also will be improved in this study.

1.2 Problem Statement

Nowadays, energy harvesting from road pavement has become a research hotspot. Besides, road surfaces have been continuously exposed to two phenomena such as solar radiation and vehicle loads. It is possible to extract energy from both of these by using specific technologies that can be transformed into electrical energy.