

**ENERGY HARVESTING THERMOELECTRIC POWER GENERATOR FROM
HUMAN BODY UNDER DIFFERENT CONDITIONS**

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**This report is submitted in partial fulfillment of requirement for the Bachelor of
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BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek ENERGY HARVESTING THERMOELECTRIC POWER GENERATOR
FROM HUMAN BODY UNDER DIFFERENT CONDITIONS

Sesi Pengajian

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DEDICATION

TO MY PARENTS

Mohd Radzi Bin Zainol Abidin and Che Hos Binti Abdul Rahman

MY SUPERVISOR

Dr. Azdiana Binti Md Yusop

MY SIBLINGS

Haslina Mohd Radzi, Mohd Ridzwan Mohd Radzi, Muhammad Khalis Mohd Radzi

MY FRIENDS

Siti Nordyana, Taufiq Tajudin, Shafiq Sofian, Imanuddin Ahamad

Dedicated in thankful appreciation for your support, encouragement and best wishes.

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ABSTRACT

Statistic shows that only half of the energy become useful energy and the rest are contribute to energy loss or waste heat. In order to reduce waste heat, thermoelectric power generator (TEG) is one of the effective solutions to produce energy from waste heat. A thermoelectric power generator (TEG) is usually having two junctions incorporating different metals or alloys. If heat is introduced to a circuit at the junction of two different conductors, a current will be generated. This project presents a wearables thermoelectric power generator using body heat. The objective of this project is to analyse the human body heat in difference ambient temperature and analyse the electrical characteristic of a thermoelectric power generator. In this project, the prototype of thermoelectric power generator (TEG) has been designed to approve that the system can generate electricity using waste heat. Three difference analysis has been done to present the difference of voltage output that is produced by the thermoelectric power generator. The result shows that the output generated from thermoelectric power generator (TEG) for the analysis of difference ambient temperature is 95.68 mV in ambient temperature is in the morning. Meanwhile, for the difference activities of the human body, the voltage output is 93.7 mV for the running activity and for the analysis of difference cloth rubber cloth shows the highest output voltage which is 89.90 mV. This voltage is lower than expected value due to the inability to control temperature differences between heat supplies and cooler to achieve the maximum voltage produced from the thermoelectric power generator (TEG). This project could be a milestone in reducing electricity usage from natural resources and lowering the cost of generating electricity. In addition, this project also reduces the amount of pollution caused by waste heat.

Keywords: *thermoelectric power generator, harvesting, human body*

ABSTRAK

Statistik menunjukkan bahawa hanya separuh daripada tenaga yang menjadi tenaga yang berguna manakala selebihnya adalah penyumbang kepada kehilangan tenaga atau haba buangan. Dalam usaha untuk mengurangkan haba buangan, penjana termoelektrik (TEG) adalah salah satu penyelesaian yang berkesan untuk menghasilkan tenaga elektrik dari haba buangan. Penjana buangan (TEG) biasanya mempunyai dua persimpangan yang menggabungkan logam atau aloi yang berbeza. Jika haba diperkenalkan kepada litar di persimpangan dua konduktor yang berbeza, arus akan dijana. Projek ini membentangkan tentang penjana kuasa termoelektrik (TEG) yang boleh dipakai untuk menyerap haba badan. Objektif projek ini adalah untuk menganalisis haba tubuh manusia dalam perbezaan suhu ambien dan menganalisis ciri-ciri elektrik penjana kuasa termoelektrik. Dalam projek ini, prototaip penjana kuasa termoelektrik (TEG) telah direka bentuk supaya boleh menjana tenaga elektrik menggunakan haba buangan. Tiga analisis yang berbeza dilakukan untuk menunjukkan perbezaan voltan keluaran yang dihasilkan oleh penjana kuasa termoelektrik. Hasil kajian menunjukkan bahawa keluaran yang dijana daripada penjana kuasa termoelektrik (TEG) untuk analisis perbezaan suhu ambien adalah 95.68 mV dalam suhu ambien pada waktu pagi. Sementara itu, bagi perbezaan aktiviti tubuh manusia voltan keluaran adalah 93.7 mV untuk aktiviti berjalan dan untuk analisis perbezaan kain, kain getah menunjukkan voltan keluaran yang tertinggi iaitu 89.90 mV. Voltan ini adalah lebih rendah daripada nilai dijangka disebabkan oleh ketidakupayaan untuk mengawal perbezaan suhu antara bekalan haba dan sejuk untuk mencapai hasil voltan maksimum dari penjana termoelektrik (TEG). Projek ini boleh menjadi salah satu pencapaian dalam mengurangkan penggunaan tenaga elektrik daripada sumber semula jadi dan mengurangkan kos untuk menjana tenaga elektrik. Di samping itu, projek ini juga mengurangkan jumlah punca pencemaran oleh haba buangan

Kata Kunci: *penjana kuasa termoelektrik, tenaga buangan, tubuh badan*

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LIST OF SYMBOLS & ABBREVIATIONS

TEG	-	Thermoelectric power generator
TE	-	Thermoelectric
FEMA	-	Federal Emergency Management Agency
CO	-	Carbon Monoxide
SO ₂	-	Sulphur Dioxide
NO ₂	-	Nitrogen Dioxide
O ₃	-	Ozone
E _{emf}	-	Electromotive Force
EMF		Electromagnetic Field
TEM	-	Thermoelectric power generator module
TPG	-	Thermo power generation
σ	-	Electrical conductivity
λ	-	Thermal conductivity
α	-	Seebeck coefficient
PDMS	-	polydimethylsiloxane
poly-Si	-	polycrystalline silicon

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CHAPTER I

INTRODUCTION

This chapter will discuss about the general introduction of this research, outline the current problem situation, objective of the project, define terms and scope of the project, methodology and significant of study.

1.1 Background

1.2 Problem Statement

Firefighter is a profession that carries significant risk for example chance of injury, loss and damage. According to the study 70 % of all duty, deaths and injuries are mostly occur during emergency activities. Federal Emergency Management Agency's (FEMA) report Fire- Related Firefighter Injuries Reported to the National Fire Incident Reporting System (2012-2014) states that each year, one out of ten firefighter will be injured during fighting with fire, rescue people or do their job training, thus the safety of firefighter is also important other than victims. Besides, many advancements in the prevention of fire injury and death over the past century but they does not addressed the fire safety needs for the firefighter. There are a lot of factor that may cause the firefighter injured during saving the victims which is heavy smoke, slippery surfaces, collapse and etc. [1] For examples, if firefighter was collapse in the building and no ones with him this may cause loss of life

if they did not notice it. In any case, the firefighter need some device that can detect the condition of the firefighter so that it can be rescue.

International Association of Fire Fighters report about Heart Disease in the Fire Service states that firefighter is one of the dangerous occupation. Besides that, this job is one of the popular occupation that risk in cardiovascular disease because of been expose to the burns and heavy smoke inhalation. In addition, the heart or cardiovascular disease is one of the most frequent cause of duty related to the fatalities among the firefighter. However, the precaution has been made to prevent this problem such as protective gear, masks and etc. but this things are often worn for a limited period only. [2][3] This means, this things cannot last for a long time.

From Table 1.1, shows that among all the duty of firefighter, duty in operating at fire ground has the highest number of firefighter death which is 46 % compare to all the duty which is responding to or returning from alarms, operating at non-fire emergencies, training and other duty. The second high percentage is training and other duty which is both is 21 percentage. The total number of death is 24.

Table 1.1: On- Duty Death Career Firefighter [4]

Type of Duty	Career Firefighters	
	Number of Deaths	Percent of Deaths (%)
Operating at fire ground	11	46
Responding to or returning from alarms	0	0
Operating at non-fire emergencies	3	13
Training	5	21
Other on duty	5	21
Totals	24	100

Figure 1.1 shows that the number of firefighter death over the years. From the graph, the highest number of firefighter was recorded is 174 in 1978. In 2015, 68 firefighter death that year. Every years there will have death cases, thus to ensure this cases decreases some sort of safety precaution must be taken.

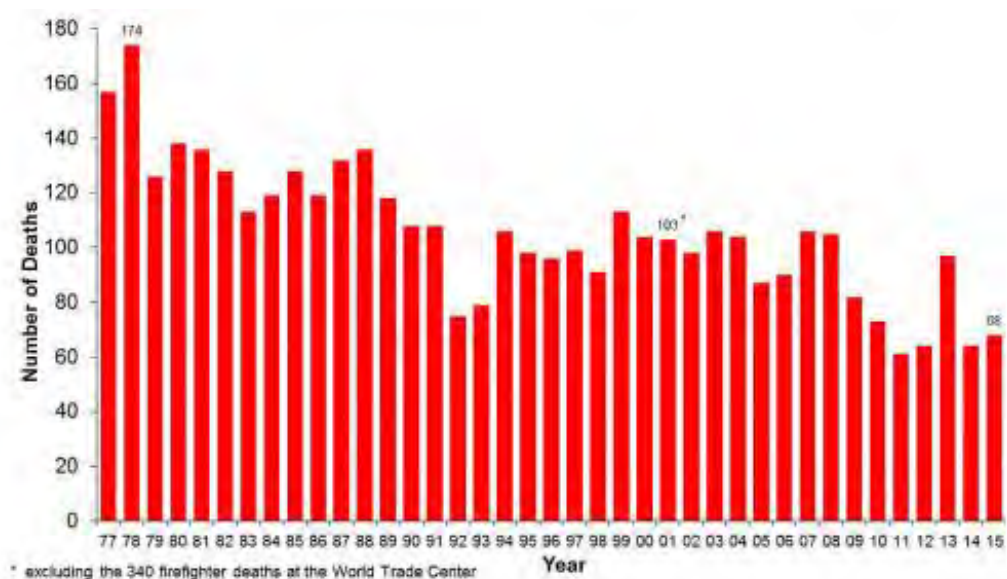


Figure 1.1: Number of firefighter death over the years. [4]

Nowadays, we are all working to protect the environment, however, excessive use of electricity leads to the environmental pollution and global warming. All forms of electricity produce some waste and it will make the environment become worst. Electricity itself is not naturally harmful to the environment. But, all the necessary things to produce electricity can be harmful to the environment and if we are continued increase in electricity consumption it will leads to global warming. Besides, the largest contribution to this problem of pollution is through emissions of carbon dioxide and monoxide, which comes from automobile, nuclear power plant and other, which leads to global warming today.

As shown in Figure 1.3, only small amount of the energy is become useful energy while rest of the energy is contribute to the waste heat or energy loss. Unfortunately, the heat waste is dangerous gasses to the environment such as Carbon Monoxide (CO), Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Ozone (O₃) and Suspended Particulate

Matter. Therefore, in order to reduce the consumption of electricity, there is one effective solution which is using the waste energy, thus this thermoelectric power generator can produce energy from waste heat.

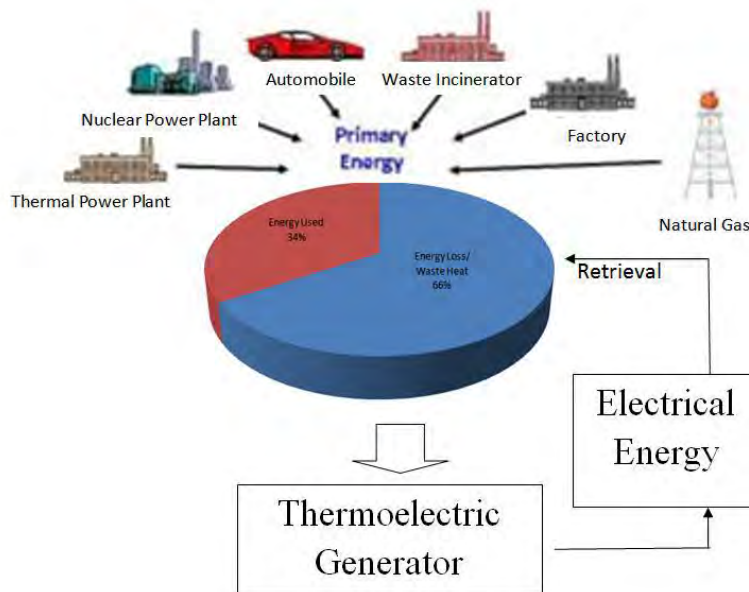


Figure 1.2: The percentage between energy used and energy loss from primary energy

However, the wearables TE power generator based on emergency response has yet been implemented. Therefore, this project will develop the use of thermoelectric power generator. Besides, as we know work as a firefighter is one of a dangerous job because they put their life in the line. Resent years, there are some news about the firefighter died while trying to save the civilian, this shows firefighter also may be involves into death. So that, this project will introduce the use of thermoelectric (TE) power generator as power supply to the heartbeat sensor for emergency response.

1.3 Objective of the Project

Based on the problem, the main objective of this project are:

1. To analyze the human body heat changes in different conditions.
2. To analyze the electrical characteristic of thermoelectric power generator (TEG) under different conditions.

1.4 Scope of the Project

The scope of work includes:

1. Determines the voltage of human body in difference ambient temperature.
2. Identify the voltage harvest from TEG depends on the temperature.
3. Identify the temperature of human body in different ambient temperature.
4. Identify the voltage harvest from TEG when a person doing difference activities.

Limitation:

1. TEG only produce small amount of voltage when the temperature is low.
2. TEG can be use when it have contact with the skin.
3. The voltage produce by the TEG is not constant because of temperature.

1.5 Methodology

The flowchart of the project consists of methodology used to construct this project shown in Figure 1.3. Based on Figure 1.3, first step to develop this project in the planning stage, some research about knowledge and concept ideas about this project are have been studied. Second step is designing the circuit according to the research than after circuit has been designed, the testing of the circuit by conducting the analysis has been done.

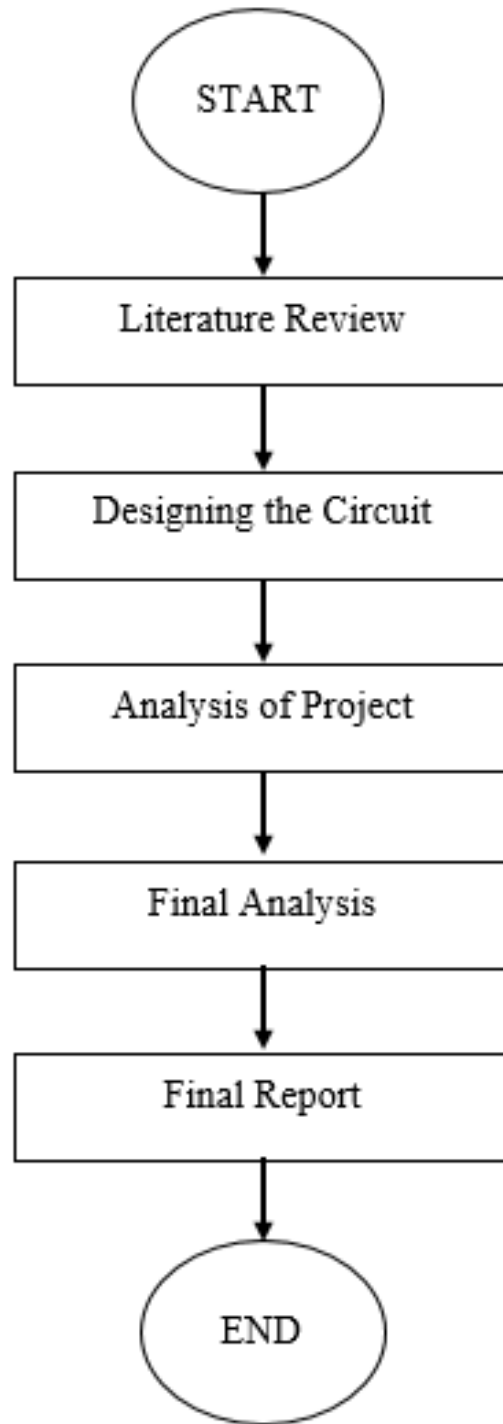


Figure 1.3: Project Methodology Flow Chart

1.6 Significant of Study

Based on the problem statement and the objective of the project, assume that this project could be a mile stone in reducing electricity usage from natural resources. This system can be operating in an autonomous and self-powered manner. This study also can reduce pollution to help towards green technology. Reuse the heat waste can help in conserving natural resources for beneficial purposes. Besides, this study also help to improve the safety of firefighter from any undesirable situation.

1.7 Thesis Outline

This thesis consist of five chapters' organization structure which is introduction, literature review, methodology, result and analysis and conclusion and recommendation. Each chapter will elaborate details about the topics involves in this report.

Chapter I: Describes about the general introduction of the thermoelectric power generator. This chapter also consist of problem statement, objective of this project, scope of project and methodology.

Chapter II: This chapter will discussing about all the related materials including journal, book and technical paper that would provide needed information and also extra knowledge about this research. These resources are used to support the result outcome by obtaining from the experiment.

Chapter III: This chapter is about the methodology of this project which is explain about the flow of the project and the requirement needed.

Chapter IV: Present about the final output and the result of the analysis that has been done in this project. All the result will be explained in this chapter.

Chapter V: Discusses about the conclusion and some suggestion for further recommendation on this project enhancement.