DESIGN AND DEVELOPMENT OF ENERGY CONVERSION SYSTEM BY USING THERMOELECTRIC GENERATOR (TEG)

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ABSTRACT

This project is about to design and develop a system using the Thermoelectric Generator (TEG) for powering low voltage portable electronic equipment's. Thermoelectric Generator modules directly convert heat energy to electrical energy and can be used an alternative energy. The waste heat can be used as main source in this project to convert heat energy into electrical energy. The TEG that is used in this project able to generate small voltage when it starts heated. The different temperature between hot side and cool side will generate the small voltage. The boost converter circuit is designed specially to increase the voltage generated from TEG. The designed circuit according the input and output voltage desired. The boost converter is fully controlled by the PIC microcontroller where it controls the switching of circuit. In order to generate small voltage, temperature plays the main role. The temperature controller is specially designed for control the TEG temperature. The output of boost converter 5V directly can be to powering the electronic devices.

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ABSTRAK

Projek ini adalah untuk merekabentuk dan membangunkan satu sistem menggunakan peranti termoelektrik Generator (TEG) untuk menjanakan peralatan elektronik mudah alih. Modul termoelektrik Generator berfungsi menukar tenaga haba kepada tenaga elektrik dan boleh menjadi tenaga alternatif. Haba yang terbuang boleh digunakan sebagai sumber utama dalam projek ini untuk menukar tenaga haba kepada tenaga elektrik. TEG yang digunakan dalam projek ini dapat menjana voltan yang kecil apabila ia mula dipanaskan. Suhu yang berbeza antara bahagian yang panas dan bahagian yang sejuk akan menjana voltan yang kecil. Litar rangsangan penukar direka khas untuk meningkatkan voltan yang dijana daripada TEG . Litar direka mengikut voltan masukan dan keluaran yang dikehendaki. Rangsangan penukar dikawal sepenuhnya oleh mikropengawal PIC di mana ia mengawal pensuisan litar. Dalam usaha untuk menjana voltan yang kecil , suhu memainkan peranan utama. Pengawal suhu direka khas untuk mengawal suhu TEG ini. Keluaran rangsangan penukar 5V langsung boleh untuk menjanakan peralatan elektronik.

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TABLE OF CONTENT

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5.0 CONCLUSION & RECOMMENDATION

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LIST OF FIGURES

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LIST OF TABLES

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LIST OF ABBREVIATIONS

TEG – Thermoelectric Generator

EMF – Electromotive Force

DC – Direct Current

FYP – Final Year Project

USB – Universal Serial Bus

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CHAPTER I

INTRODUCTION

1.1 Project Overview

The wasted heat that can cause global warming can be converted into something useful in our life. The aim of project is to apply the Thermoelectric Generator module to generate electricity from any waste heat such as barbeque set, motorcycle exhaust, home heater and others source can produce heat. This project is design and develops a portable device as an alternative energy. The thermoelectric generator module can be converted to electrical energy based on thermocouple concept. The boost converter is used to step up the small DC voltage that is produced from thermoelectric generator module.

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1.2 Objective of Project

There are several objectives involved in this project that should be focused to in order to achieve the design of the project.

i. To design a reliable portable device that can generate electricity by using the thermoelectric generator.
ii. To design the boost converter to step up small voltage.
iii. To design the temperature controller for devices system.

The first objective is to design a portable device that can generate by using the thermoelectric generator and operate effectively. Thermoelectric module was used in this device system to convert thermal energy into electrical energy which it can be utilized at certain temperatures to operate and produce small voltage.

The second objective is use boost converter to increase small voltage generated by the thermoelectric module. The voltage generated from thermoelectric module too small and the boost converter is design based on the desired input and output. The PIC Microcontroller used to control the switching of MOSFET. The Pulse width modulation (PWM) is important where it will determine the output of boost converter based on input from thermoelectric module.

The third objective is to design the temperature controller for devices system. The thermoelectric module concept, it will operate when it has a temperature difference of hot and cold. The temperature controller is design to overcome the overheat problem.

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1.3 Problem Statement

Nowadays, cause of the increasing awareness of global warming, we are finding ways to cut down their greenhouse gases emission. Thermoelectric is one of possibilities to recover wasted heat and convert it back to useful form of energy like electricity. This wasted energy can be used as an alternative energy to keep electronic equipment running.

Most of peoples facing problem to electronic devices when no electricity source. The source of electricity is very important for us to keep electronics device running every time and everywhere. As for this project, the proposed solution is to design and development of fire thermoelectric device for alternative energy can overcome the problem where it will be good option to cut down their greenhouse gases emission.

1.4 Scope of Project

In order to achieve the objective of the project, several scopes need to be identified. The scope of the project includes:

i. Develop the TEG converter system that able to produce an output in the range of 2V to 4V.
ii. Design and fabricate boost converter circuit. The boost converter circuit is fixed but still need to redesign to get the circuit comfortable with application.
iii. Design temperature controller circuit to control the heat of thermoelectric module.

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1.5 Project Methodology

In order to complete this project, a number of methods used to ensure that projects are produced to achieve the target. It is divided into five phases:

Phase 1: Software Design

The software design for the project is to design the boost converter circuit and temperature controller by using Proteus software. The PIC simulation is used for analysis the outcome expected result and to control the PWM signal for boost converter circuit

Phase 2: Hardware Development

Construct thermoelectric converter and assemble the component for boost converter circuit and temperature controller circuit.

Phase 3: Hardware Testing

In this phase, testing functionality of each hardware

Phase 4: Hardware and Software Implementation

This phase involve each circuit having connection each other.

Phase 5: Data Analysis

Finally, data will be collected for analysis and suggestion will be discuss in order to overcome the weakness of the project in the future.

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1.6 Thesis Outline

This thesis report contains five chapters, consist introduction, literature review, methodology, result and discussion and last the conclusion of project. Each chapter explains detail about entire project to provide the understanding of the whole project.

Chapter one is introduction about the project. This chapter explain an overview overall of the project, objective of project, problem statement of project, scope of project, project schedule and thesis outline.

Chapter two present the literature review on the component that used in this project. The theory of all components, equipment and programming language that is used in this project also included. This chapter discuss all the source of article that related to this project and also reveals the product that been appeared in the market.

Chapter three discusses detail about projects methodology. It is also include project planning, and project finishing. All the progress is keep running follow the project planning. In this chapter, a flow chart is built to show the progress clearly and also use the Gantt chart for semester 1 and semester 2.

Chapter four is contain of the result and discussion overall for this final year project. In this chapter discuss about theory of thermoelectric concept and boost converter system that an important part to build this project. These chapters also discuss the result of thermoelectric temperature and output, boost converter output and the temperature controller function.

Chapter five discuss about the conclusion based on the objective that specified in introduction part. Beside that's also discussed about the future work suggestion for improvement on this project.

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CHAPTER II

LITERATURE REVIEW

2.1 Overview

This chapter describes and discusses all of the sources and articles that has been studied and related to the project. Beginning of this chapter will describe the project in the current market. The project will be compared with the project that was designed. In addition, this chapter also describes all equipment, components and programming languages that are used in the project. The whole system of the project will be compared, and the comparison of inputs, outputs and devices also included. From the literature review, the advantages and disadvantages between projects will be analysis. All information such as operation and specification of project also stated.

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2.2 Case Study

The project is about Heat Energy Harvesting for Portable Power Supply (PosHEAT). This project designs a portable and compact thermoelectric generator that can be carried and used anywhere since we have the source of heat needed to convert .The energy produced by the waste heat will used to charge mobile phones and was stored in rechargeable batteries. The project concept, from waste heat will produces electrical energy as a renewable energy [1].

PosHEAT was designed with has attractive futures such as completely silent, no emission to produce electricity and no moving part, and reduced maintenance. The project use thermocouple concept, where voltage is produces in the presence of a temperature difference between two different metals. Seebeck made from Bismuth Telluride (Bi2Te3) are used where it the good material to generate more power. PosHeat will function generate electrical energy from heat energy when there is the different of temperature between the two sides of Seebeck. The project is use the temperature to produce power as an input [1].

The minimum requirement, the Seebeck unit needed Seebeck coefficient (S) greater than 122 μV/K. As a conclusion the best performance of generator depend on the P-N element couples of Seebeck unit. This project is used 127 P-N element couple to generate enough power [1].

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The results for the prototype are presented in Table 2.1. The table shown the difference temperature can produce difference value of voltage, current and power.

Table 2.1: Experiment Result

No	Difference Temperature (^{O}C)	Voltage (V)	Current (A)	Power (P)
1	15	1.9	0.35	0.67
2	30	2.5	0.40	1.00
3	45	3.0	0.48	1.44
4	60	3.8	0.52	1.97
5	75	4.4	0.62	2.73

Figure 2.1 show the output graph of voltage versus time. The voltage increase and stable above 4V for a long time.

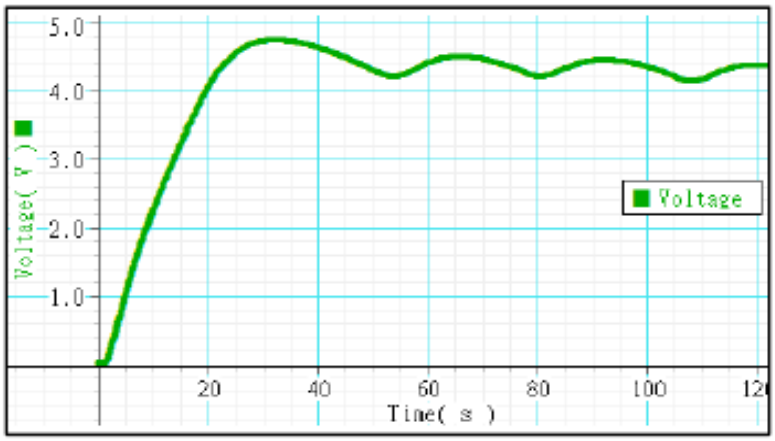

Figure 2.1: Voltage Versus Time

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Figure 2.2 show the current versus time. The TEG start heating and the highest current will be on 0.6 A and it will drop to 0.4 A and stable.

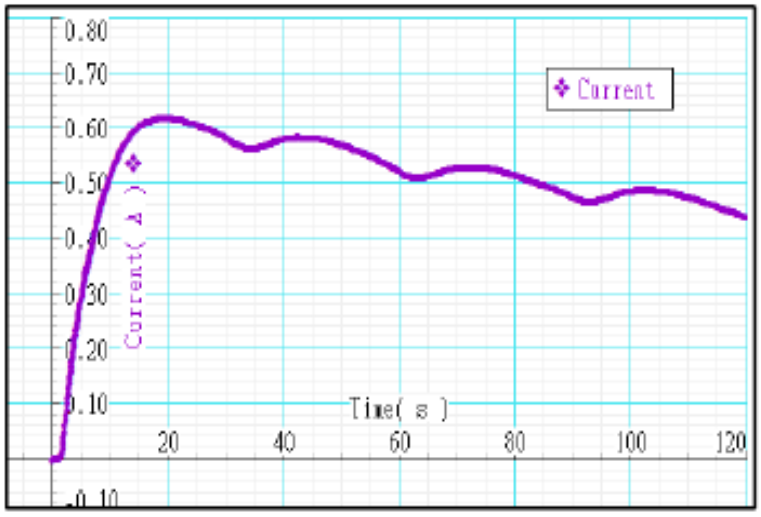

Figure 2.2: Current Versus Time

Figure 2.3 show the TEG device body come with heat sink was installed on the motorcycle exhaust pipe. The exhaust pipe can produce wasted heat and enough to heating the TEG.

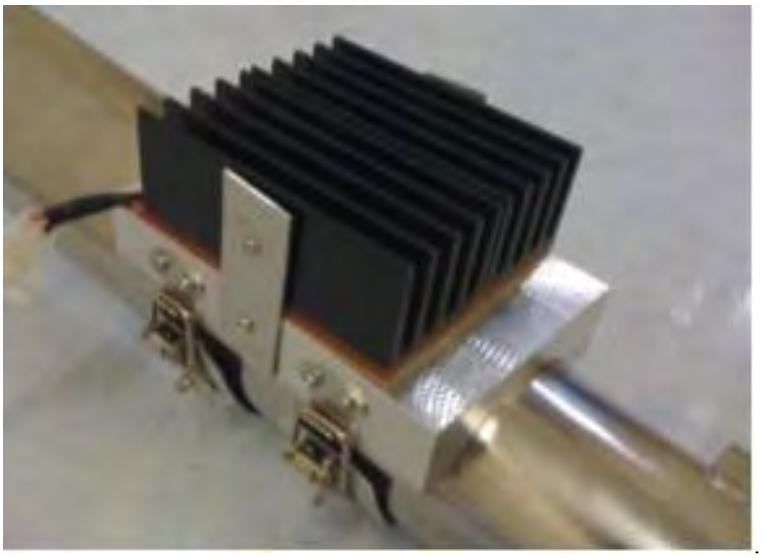

Figure 2.3: Product Attached At Exhaust Pipe

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