DECLARATION

"I, hereby declare that this thesis with title DEVELOPMENT OF PORTABLE ELECTRICITY GENERATOR USING PELTIER FOR SMALL APPLICATION is a result of my own research idea concept for works that have been cited clearly in the references."

Signature **:……**

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Date **:** 9 DECEMBER 2016

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory committee is as follow:

……

(Principal Supervisor)

ABSTRACT

Application of Thermoelectric Generator (TEG) for Projek Sarjana Muda (PSM) is a new innovative system, to develop the solution based on the current scenario in producing portable electricity generator for small applications. Furthermore, green technology are really needed for future due to energy crisis and environment deterioration. It generate the electricity from a temperature difference and it is about how electrons move in a metal. Heating one end of a thermoelectric material causes the electrons to move away from the hot end towards the cold end. When the electrons go from the hot side to the cold side this causes an electrical current, which it helps to generate electricity. This electricity can be step up for some value that suitable for small applications. However, several thermoelectric modules can be connected in series or parallel to provide the required voltage and current. In most thermoelectric generator systems the individual thermoelectric modules are subject to temperature mismatch due to operating conditions. Thermoelectric is a device that need low cost of maintenance as they works electrically without any moving parts so they are virtually maintenance free, environment friendly as the thermoelectric generators produce no pollution. To be conclude that this application of portable electricity generator for small applications is to create a device for green technology. It is the best method for recovery of waste exhaust heat. The main advantage of this application is, it produces power from the renewable source.

ABSTRAK

Pemakaian Termoelektrik Generator (TEG) untuk Projek Sarjana Muda (PSM) adalah satu sistem baru yang inovatif, untuk membangunkan penyelesaian berdasarkan senario semasa dalam menghasilkan penjana elektrik mudah alih untuk aplikasi kecil. Tambahan pula, teknologi hijau sangat diperlukan untuk masa depan kerana krisis tenaga dan kemerosotan alam sekitar. Ia menjana elektrik daripada perbezaan suhu dan ia adalah mengenai bagaimana elektron bergerak dalam logam. Pemanasan satu bahagian bahan termoelektrik menyebabkan elektron bergerak dari bahagian panas ke arah bahagian sejuk. Apabila elektron pergi dari sebelah bahagian panas ke bahagian sejuk ini akan menyebabkan arus elektrik, yang ia membantu untuk menjana elektrik dimana elektrik ini boleh ditingkatkan untuk beberapa nilai yang sesuai untuk aplikasi kecil. Walau bagaimanapun, beberapa modul termoelektrik boleh disambung secara siri atau selari untuk menyediakan voltan dan arus yang diperlukan. Dalam sistem penjana termoelektrik modul termoelektrik individu adalah tertakluk kepada perbezaan suhu untuk beroperasi. Termoelektrik adalah alat yang melibatkan kos rendah dalam penyelenggaraan kerana ia bekerja secara elektrik tanpa apa-apa bahagian yang bergerak maka ia adalah satu alat elektronik yang boleh dikatakan penyelanggaraan percuma, mesra alam sebagai penjana termoelektrik yang tidak menghasilkan sebarang pencemaran. Kesimpulannya penjana elektrik mudah alih untuk aplikasi kecil adalah untuk mencipta alat untuk teknologi hijau. Ia adalah kaedah terbaik untuk pemulihan sisa haba. Kelebihan utama projek ini adalah, ia menghasilkan kuasa daripada sumber yang boleh diperbaharui.

DEDICATION

I dedicate this thesis to my family and friends who involved in sharing knowledge and support me doing my thesis.

Most thankful especially to my supervisor Puan Emy Zairah Binti Ahmad in supervise me along completing my thesis.

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The completion of this project could not been possible without the guidance and participation of so many people who sincerely helping me. Their contribution are sincerely appreciated and gratefully acknowledged. I would like to extent this appreciation to those who have helped me directly or indirectly in the completion of this project.

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Above all, to the Great Almighty, the author of knowledge and wisdom, for his countless love.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

TEG	=	Thermoelectric Generator
TE	=	Thermoelectric
TEM	=	Thermoelectric Module
ΔT	=	Difference Temperature
ΔV	=	Difference Voltage
DC	=	Direct Current
Emf	=	Electromotive Force
Z	=	Merit

CHAPTER 1

INTRODUCTION

1.0 Background

Electricity is one of the most important where science has given to mankind. Electricity has become useful and changed everyone's life since the day it was discovered. The way to get electricity have a few of sources. There are from photo voltaic energy, non-renewable fuels, hydroelectric energy, nuclear energy and wind energy. Photo voltaic energy arise from sun's sun rays. Fossil fuel arise from material that might be burned for instance coals. Hydroelectric arise from the produced energy in the water falls. Nuclear energy arise from the produced consequence of the nuclear energy station. Lastly, wind energy produced from wind mills.

Nowadays, thermoelectricity phenomenon had been used mostly in various sector. It comes from the concept of thermocouple, which gives concept of obtaining a potential difference which is maintain two junction at different temperature. The higher the differences between both sides of temperature, the higher the electricity can be produced from the thermoelectric device. A few of research on peltier had been conducted. The use of thermoelectric generator (TEG) produce a current flow in an external circuit by the imposition of a temperature difference across the thermoelectric generators (TEG). The magnitude of temperature difference determine the magnitude of the voltage difference and the direction of the heat flow determine the voltage polarity. Thermoelectric effects can be used to make solid-state refrigeration devices, or sense the temperature differences, or to convert thermal energy directly into electricity. Thermoelectricity generators are solid-state heat engines that operate according to the Seebeck Effect where the theory claimed a temperature difference

across thermoelectric material can be converted directly into electrical power. Inside the peltier, the materials are made up from more than one pairs of p-type and n-type elements.

In other words, thermoelectric generate the electricity from a temperature difference and it is about how electrons move in a metal. Metals are good conductors because electrons can move freely within them, same as fluid in a pipe. When raised the pipe it will increased the potential energy and the water will flow downhill. In a thermoelectric material the same things happen to the fluid-like electrons when it is heated. These effects are not at all specific to semiconductors. However, semiconductors are particularly suitable for thermoelectric applications. The reason is that the nature of the current carriers in semiconductors can be manipulated. That is done by doping the material. In an n-type doped semiconductor, currents are carried by mobile electrons. In a p-type doped semiconductor, the currents are carried by mobile holes, quantum states from which electrons are missing. Electrons are negatively charged particles, but holes act as positively charged ones. That is because a negatively charged electron is missing from a hole.

Throughout the process of how peltier effect works, it shows that the thermoelectricity phenomenon have a big potential for green technology. Because, the source of this energy is from thermal energy where it arise from sun's radiation. Green technology is very useful for the future of environment.

1.1 Problem Statement

Nowadays, electricity plays a key role in keeping homes and business running smoothly, powers transportation that take people to work, school and other places and supplies electricity to appliances in all sectors. The discovery of electricity is one of the greatest achievements of mankind. There have been too many wasted energy from the ambient environment which can be converted into something that can be useful for daily users. However, users are too dependent on non-renewable energy as their source

of energy. Through this situation, people's problem can be solved by changing their life style by using renewable energy for instance, use the thermal energy sources. In this project, thermoelectric generators (TEG) is used as a device for producing electricity. This thermoelectric generator (TEG) will produce current when there are temperature difference occur between both sides of the peltier. The higher the differences between both sides of temperature, the higher the electricity can be produced from the thermoelectric device.

This project focused on green technology which is produced energy without using fuels or any source that can harm environment. In addition, this project able to be a portable power generator for small application for example, lamp, charger battery and etc. Moreover, if someplace inland facing with problem to get power source to light up a lamp, this project can help to give an alternative for this issue.

1.2 Objectives

The objectives of this project are:

(a) to develop an electrical energy generator device using the concept of peltier for small application.

(b) to analyse the performance of the designed system

1.3 Scope

There are a few of objectives need to be achieved in this project, so it has some scope and limitation. For implementing this project, first step is designing the portable electricity generator sizing that use peltier or thermoelectric generator (TEG). The design of this project is very important to consider for suitable size because it is a portable device. Since it is a device that produce low energy, it is not suitable to have a large size. Then, the overall system and circuit will be designed by incorporate the peltier device with other element for a complete circuit. Failed of designing circuit will effected the operation of this project. Simulation for the design circuit will be presented before implementing the project. Other elements that used for this project are battery, switch, metal plate, regulator and load. If the circuit functioned as well, this project will moving on developing the project guided by the design of the overall system. For limitation of this project, if perhaps the circuit not work as expected. Finally, this project will be tested due to its performance for generating electricity.

1.4 Project Significant

Based on previous research conducted by many of researchers, it shows that any device that capable to generate power on itself have a big potential for future green technology. For this project, the proposed design actually discover a new alternative that can be experienced by peoples with an innovation of creating electrical energy. Related to this project, as a portable electricity generator using peltier effect, it may have more than one advantage for peoples. For instance, portable electricity generator able to provide electricity for people that facing with electrical source at village inland. In addition, portable electricity generator able to create a system that harmless for environment. Besides, this project will be able to encourage peoples for not too depend on non-renewable energy sources. Thermoelectric generator (TEG) system of charging the battery could reduce the fuel consumption and also battery life used in automobiles could be increased. It is the best method for recovery of waste exhaust heat. The main

advantage of TEG is that it produces power from the waste heat source. Experimental and theoretical results relating thermoelectric-to-electrical conversions using TEGs had been conducted before.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This literature review is based on related topic about thermoelectric generator (TEG) device and has given a complex explanation on how the device work. Electronic instrumentation is used to monitor and control more than one of processes. It plays an important role in a chemical enterprise, which is in few of other places. More often than not, the circuit will be provided with power from a standard outlet or by a battery. Much of the time, it is, be that as it may, not appropriate to run a link from the power source to the area of utilization in light of the fact that the harsh of environment winning in such plants, particularly for little, low-control applications like sensors. In this way, a free and dependable power source is required, all things considered. One solution is to use a thermoelectric generator (TEG) to convert low-grade energy of heat into electricity which powers the application or charges a battery backup. For understanding this device, basic theory of thermoelectric (TE) consists of two principles. There are the principle of Seebeck effect where it is main for power generation and peltier effect where it is main for refrigeration (Uchida et al, 2016). In this project, thermoelectric generator is used. Thermoelectric generator (TEG) based on the principle of Seebeck effect where it is for produce power (Uchida et al, 2016). Thermoelectric generator (TEG) produce a current flow in external circuit by the imposition of difference temperature ΔT across the TEG (Andrea et al, 2014). The magnitude of this ΔT determines the magnitude of the voltage difference ΔV and the direction of heat flow determines the voltage polarity either positive or negative on one of the side (Andrea et al, 2014).

In addition, the general utilization of fossil powers utilization by human exercises has influenced a difficult issues for air and ecological issues. Subsequently, a worldwide temperature alteration, nursery gas discharge, environmental change, exhaustion of ozone layer and corrosive rain pulverizing our surroundings. To stop the above effect of fiasco, thermoelectric (TE) vitality converters is proposed as one of the conceivable route to its capacity in changing over the warmth radiated from vehicles, electrical instruments and sun beams which is a non-renewable vitality that is not contaminated. The merits of this conversion lies in the solid-state operation, the gas-free emission, the vast scalability, the maintenance-free-operation without any moving parts and chemical reactions, no damage to the environment and also a long life-span of reliable operation. As thermoelectric devices consist of solid-state materials and not have moving parts, they are silent, reliable, and scalable (Ken-ichi et al, 2016). However, the TE devices are still in the limited application because of the low energy-conversion efficiency and the corresponding high material cost.

2.1 Energy produced by Thermoelectric (TE)

A thermoelectric generator (TEG) also called as Seebeck generator is a device that convert heat which is a temperature difference directly into an electrical energy through a phenomenon called the Seebeck effect that is a form of thermoelectric effect (Uchida et al, 2016). Thermoelectric materials generate electricity while in temperature gradient. Keeping in mind the end goal to be a decent thermoelectric, materials utilized must have the one of a kind blend of both high electrical conductivity and low warm conductivity. What is more, so as to set up high voltage while in temperature angle, its warm conductivity must be low.

The figure 2.1 below shown the versatility of thermoelectric materials which are n-type and p-type. Besides, in Figure 2.2 shown a schematic illustrating Seebeck effect of couple of two dissimilar materials which is a voltage difference (ΔV) is

generated that is proportional to the temperature gradient (ΔT) between the ends of the couple. Since, Seebeck effect is the basis for power generation.

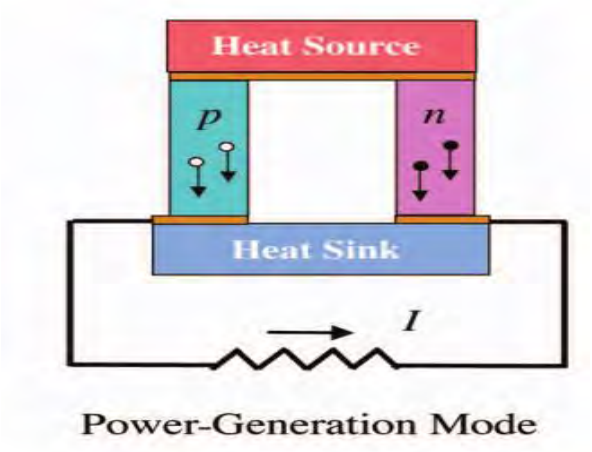

Figure 2.1: Power generation mode

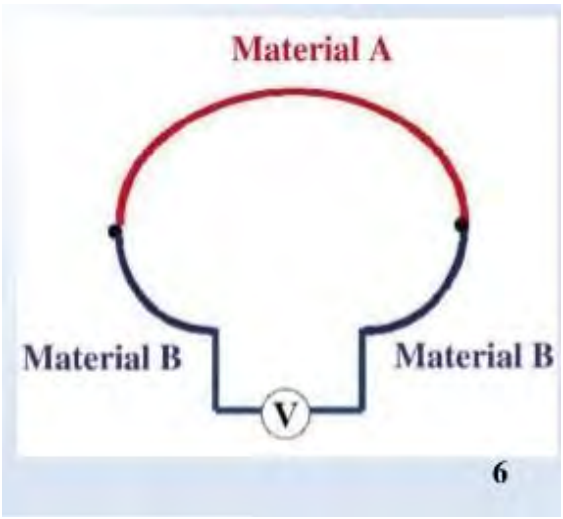

Figure 2.2: Seebeck effect

How thermoelectric generator (TEG) produce electricity? When heat is applied to one of the two conductors or semiconductors, heated electrons will flow towards the cooler one side. If the pair is connected through an electrical circuit, direct current (DC) flows through that circuit. Figure 2.3 shown how electricity produce from thermoelectric when it was heated. The thermoelectric (TE) materials enable the conversion of the temperature difference into electrical energy through Seebeck effect (Wei et al, 2014). To improve the performance of the thermoelectric module, it's being integrated with coolant to decrease the temperature of the bottom surface (Dr.K.Rathnakannan et al, 2014).

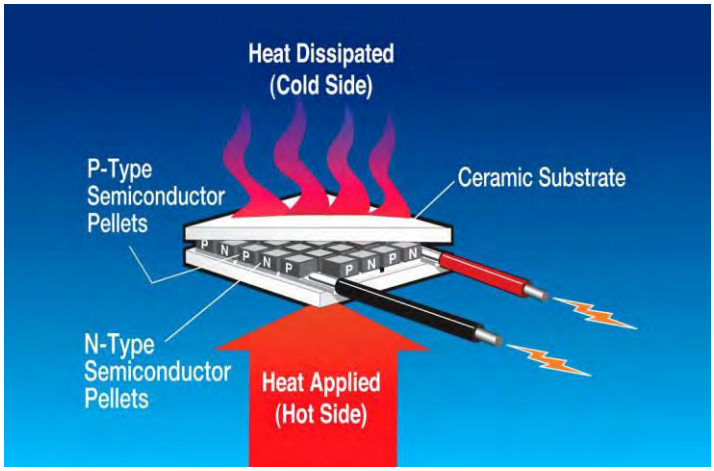

Figure 2.3: Generating Electricity from Thermoelectric Generator (TEG)

2.1.1 Influence of Heat Leakage

Heat leakage is phenomenon that thermal energy transfers from the high temperature side to the low temperature side of the thermoelectric module (Toshihiko et al, 2013). Heat transfer reduces temperature difference (ΔT). It results in decreasing in output power of thermoelectric generation.

2.2 Specification and Properties of thermoelectric generator (TEG)

The size of thermoelectric used in this report has small size with 40*40mm, light weight and long life. In the structure of thermoelectric, it has no moving parts. Besides, it is a device that high reliability and not pollute environment. Thermoelectric have two sides that need different temperature to generate any values of current. Higher the difference temperature between both sides, higher current can be generated by thermoelectric. From thermoelectric, it have two wires out from it. There are red wire and black wire. Red wire is for positive polarity and black wire is for negative polarity. It generate current when the temperature difference happened. The module of thermoelectric generator used in this report is SP1848-27145 with colour of white. For references, the generated current and open-circuit voltage for thermoelectric of this module as Figure 1 below:

Table 2.1: References for data output from SP1848-27145 (ideal)

Temperature difference (°C)	Generated current	Open-circuit voltage (V)
20	225mA	0.97
40	368mA	1.8
60	469mA	2.4
80	558mA	3.6
100	669mA	4.8

A typical thermoelectric generator (TEG) structure consists of p-doped and n-doped thermocouple pairs connected electrically in series and thermally in parallel. According with the Seebeck effect, the output voltage gained when temperature difference exist between the thermocouple junctions can be described as