



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Power Generator System using Thermal source from car

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Engineering Technology (Bachelor's Degree in Electronics Engineering Technology (Industrial Electronic) with Honours) (Hons.)

by

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**TAJUK: Development of Power Generator System using Thermal source
from car**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Department of Electronics & Computer Engineering Technology) (Bachelor's Degree in Electronics Engineering Technology (Industrial Electronics) with Honours). The member of the supervisory is as follow:

.....
(Project Supervisor)

ABSTRAK

Laporan ini menunjukkan pembangunan sistem penghasilan tenaga elektrik dalam kereta dengan menggunakan tenaga haba. Terdapat banyak tenaga yang terhasil di sekeliling termasuklah dalam sistem operasi kereta. Oleh itu, tercetus idea untuk menggunakan semula tenaga haba yang menghasilkan sumber tenaga elektrik untuk digunakan kepada peranti kereta. Tenaga haba akan dimanfaatkan dengan projek pembangunan sistem penghasilan tenaga elektrik dalam kereta dengan menggunakan tenaga haba dibangunkan

Sistem Penjimatan tenaga elektrik dalam kereta menggunakan pendekatan peltier yang menukarkan tenaga haba kepada tenaga elektrik semasa berlakunya perbezaan suhu. DC-DC pengubah *boost* digunakan untuk mengamplifikasikan voltan daripada peltier untuk dibekalkan kepada peranti kereta.

Proses penukaran yang dicapai oleh peltier dengan meningkatkan voltan yang dicapai oleh DC-DC pengubah *boost* . Suhu pada manifold ekzos merupakan tenaga haba yang akan mempengaruhi keputusan tenaga elektrik dihasilkan.

ABSTRACT

This report presents the Development of Power Generator System using Thermal source from car. Wasted energy is occurred in our surrounding all over the world including in a car operating system. Therefore, an idea of reusing the thermal and generate electric to supply car devices is occurred. In order to benefit wasted energy, a power generator system to reuse the thermal source is an essential to be installed.

The approach of power generator system is using a thermoelectric generator to convert heat source from a car to electrical source when different temperature occur. A DC-DC boost converter is used to amplify the voltage from the converted voltage and supply to the car devices.

The converting process is achieved by using peltier module and boosting process is achieved by using DC-DC Boost Converter. The temperature of the exhaust manifold which is the part of heat sources supply affecting the results of the voltage produced.

DEDICATION

I'm dedicating this project to my beloved parents who have raising me, giving full of caring and love in my life. This project is created as a way of looking back on my life and seeing the lesson I've learned.

ACKNOWLEDGEMENT

I would like to thank Miss Siti Halma Binti Johari as my supervisor for her guidance on completing this project. I would also like to thank all my friends that support me during working on this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

L	-	Inductor value
C	-	Capacitor value
V_o	-	Output Voltage
V_{in}	-	Input Voltage
L_{max}	-	Maximum Inductor value
ΔI	-	Changes of inductor value
ΔV_{outmax}	-	Changes of Maximum Output Voltage
D	-	Duty Cycle
V_L	-	Voltage of Inductor
$\frac{di_L}{dt}$	-	The rate of changes of current in Inductor
$\Delta i_{L(open)}$	-	Current Changes of Inductor when switch is open
$\Delta i_{L(close)}$	-	Current Changes of Inductor when switch is close
T	-	Period
T_{off}	-	Period when switch is close
P_{in}	-	Input Power
P_o	-	Output Power
R	-	Resistance value
I_L	-	Current value in Inductor
I_{Lmin}	-	Minimum current value in Inductor

Chapter 1 :

Introduction

1.1 Project Background

Energy cannot be create or destroy but it can be transfer into many different forms. Whenever energy is transfer, there is only a small amount will transfer into useful energy that needed and the rest of the energy is transfer into non-wanted form where it does not help us achieve our aims, so the non-wanted energy is wasted. Eventually the energies end up being transferred to the surrounding, which become warmer and the wasted energy spreads out so much that it becomes hard to reuse it. Since mostly energy is transfer to the surroundings, therefore the most common form of wasted energy is heat. Figure 1.1 represents the energy transfer with low efficiency.

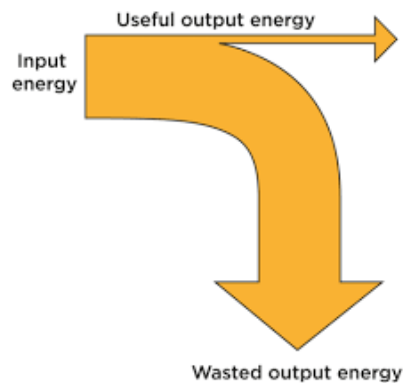


Figure 1.1 Energy transfer with low efficiency

Heat energy is spread out from car when car is functioning. Car is a common vehicle which use in transportation. It functions is to transport something from a place to a destination using less time and energy. Nowadays, cars are propelled by an internal combustion engine where input energy is fueled by gasoline or petrol and it will combust to supply the energy to move the car. In scientific terms, a car is an energy converter which can be elaborate as a machine that assimilate energy from fuel and turns it into mechanical energy to move wheels and gears. Due to the number of vehicles and distances driven by those vehicles continue to grow, it is resulting an increase of petroleum consumption and fuel efficiency. Waste heat is produce from the process involved in conversion of fuel energy to mechanical or electrical energy [1]. When the engine start working, the mechanical energy converted to kinetic energy and the car will move consistently as long as petrol is consistently supplied. In the transfer process, the energy is transfer to many types of energy and mostly energy is been wasted. Figure 1.2 shows energy loss of a car.



Figure 1.2 Energy loss of a car

The amount of energy transfer is being useful or wasted due to the efficiency of a system. The efficiency of a system is determined by the amount of the input energy is transferred to useful output energy. The greater the wasted output energy, the lesser the efficient of the system. In the car combustion process, there is only about 30% of energy from the fuel will gets used to move the car or run accessories. The rest 70% of the energy generated by the combustion of fuel in engine can't be converted into

mechanical energy, but disperses to the environment as waste heat [2]. Therefore, it's a huge amount of waste in the process of the car works.

For vehicle which is using petrol as fuel, there is fuel's energy lost in the internal combustion engine. These engines are quite inefficient at the conversion processes, energy lost due to many factor such as engine friction and wasted heat energy spread from pumping air to the engine for the combustion process.

Besides that, there are idling losses which is lost to idling at the traffic light. When a vehicle comes to a stop, the engine stops the combustion process and when traffic light becomes green, the engine needs to be restart and cause more energy consumption [3].

A vehicle must spend more energy to remove air out of the way as it goes down the road. As the air resister lower at lower speed, it consumes less energy and more as speed increases. The air resistance is related to the vehicle's shape. Smoother vehicle shapes can reduce air resistance significantly. Furthermore, there is also friction for a car against the road. To move forward, a vehicle's drivetrain must provide enough energy to overcome the vehicle's inertia, which is directly related to its weight. The less a vehicle weights, the less energy it takes to move it. In addition, any time the user use the brakes, energy is used to overcome the inertia.

There is too much of wasted energy that release from the car and a way is figure out to reduce the wasted energy by reusing the energy to convert back to useful source. The project tittle is development of power generator system using thermal source from car which uses the thermal energy that spread from car to generate electric. The main idea is use thermoelectric device which is peltier to convert heat energy to electric energy. Thermoelectric device implies the Seebeck effect, Peltier effect and Thomson

effect. Thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa.

Figure 1.3 shows the Seebeck effect experiment that is carried out by Thomas Johann Seebeck in 1821. This experiment is discovered by observing a compass needle that deflected when a closed loop was form using two different metals or semiconductors. Thomas Johann Seebeck believed that this happen because of the magnetism induced by the difference of temperatures. Therefore, Seebeck effect is defined as a phenomenon in which a temperature difference between two dissimilar semiconductors produce a voltage between the two points.

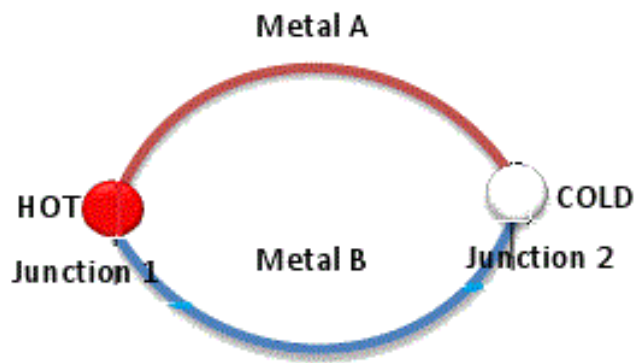


Figure 1.3 Seebeck Effect

French physicist Jean Charles Athanase Peltier discovered another type of the thermoelectric effect which is named Peltier effect in 1834. He discovered this by reversing the Seebeck effect, the temperature difference is produced at the two different electrical conductors when the current flow through the junctions [4]. The effect is shown as Figure 1.4 in the next page. In simple way, when there are temperature gradient is applied to Peltier, current is generated.

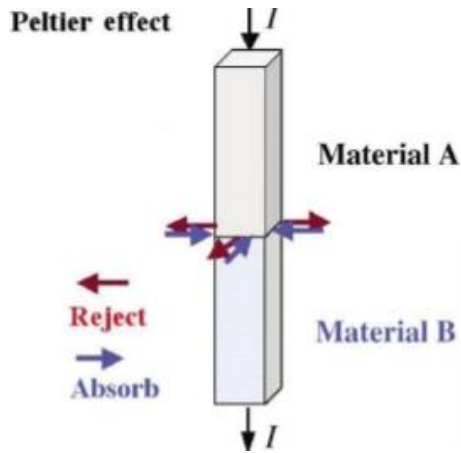


Figure 1.4 Peltier Effects

Peltier is a device that implies Peltier effect that has two plates which are cold and hot plate. This Peltier device is named as heat pump because it does not create heat or cold and it transfers the heat from one side to another side. Therefore, it is also called thermo-electric generator.

A typical thermoelectric generator will consist of an array of p- and n- type semiconductor elements that act as the two dissimilar conductors. The array of elements is soldered between two ceramic plates, which will places as electrically in series and thermally in parallel [5]. Figure 1.5, it shows that the peltier module has both side which is cold side and hot side and the arrangement of thermoelectric module.

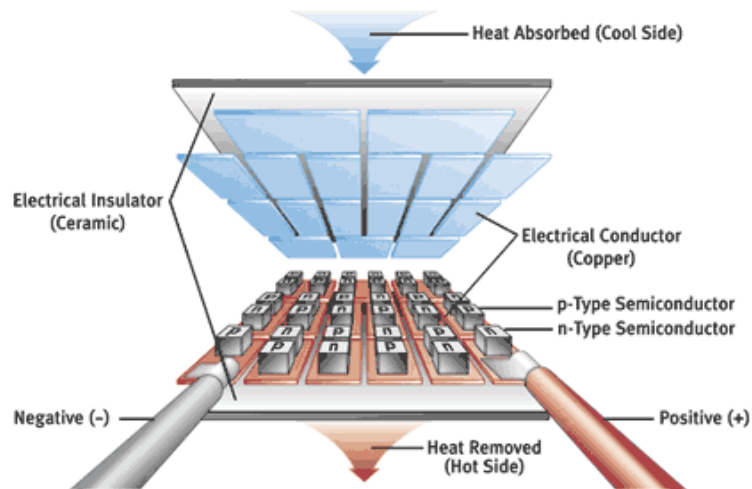


Figure 1.5 Peltier Modules

. The hot side is connected to the heat sink by dissipating the heat to the surrounding. Therefore, in the project, peltier is the main devices to convert the heat energy that spread from car to electric energy to apply in the application.

A boost converter or step-up converter is used to amplify lower input voltage to higher output voltage. In the boost converter circuit, when switch is closed, the load gets voltage supply which charges through the current passing through the inductor and when switch is open, the load gets supply from the input stage and the inductor. Figure 1.6 shows an example of boost converter.

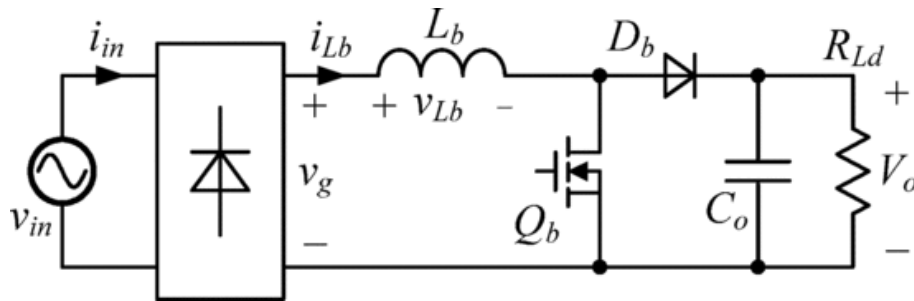


Figure 1.6 Sample Circuit of Boost Converter

The basic working principles of DC-DC boost converter operate in two modes which are Continuous Conduction Mode and Discontinuous Conduction Mode. For low-power applications, converters are often operated in the discontinuous conduction mode, while high-power applications operate in the continuous conduction mode [6].

This project is to study the peltier working principle, efficiency of energy conversion, estimate the output voltage and current values of the related application and stabilize the power source using DC-DC boost converter, design of the circuit with peltier devices, dc-dc converter and the controller. These are the four main parameters to be studied in this research in order to improve the efficiency of the project and my expectation for this project is the alternative power supply is converted from thermal energy to electric energy and supply to car devices. The project is named as Smart Conversion Power Generator.

1.2 Problem Statement

There are much usable energies that usable in our normal life style but most of the energy will be ignore. Thermal energy are one of the energy that spread from car but the energy is not been used for any function. Smart Conversion Power Generator is to use the thermal energy that spread from car, convert it to electric and supply to related devices. There are some problems when research is found about this title. The DC-DC converter converts the thermal energy to electric energy using DC-DC converter. The output voltage is unstable because it might produce the voltage that not in the desire range. Smart Conversion Power Generator need a stable and fix voltage range so that it maintains the wellness of the devices. Besides that, a way to test the temperature data that spread by the car is needed. The temperature data will have substantial change and hard to record the data. The device must be mobility and can receive high temperature data. Next, the design of the project has to cover two different temperature which are low temperature and high temperature. The resource of high temperature will be places near car exhaust manifold since it was the heat output of an engine. The resource of the low temperature plate should face outer site of car because the air will pass by the car and obtain a lower temperature when a car move. The design of the project has to be studied.

1.3 Objective

The objective of this project are :

- i. To study the working principle of peltier and DC-DC boost converter.
- ii. To implement a new power generator system by reusing the wasted thermal energy that spread from car.
- iii. To obtain a stable output electric source and the output devices is functioning well.

1.4 Scope

In Smart Conversion Power Generator, the aim is to develop of power generator system by reusing the wasted thermal energy that spread from car as input source and generate electric energy to related car devices by using DC-DC converter and several technique factors is studied such as the peltier working principle, efficiency of energy conversion, estimate the output voltage and current values of the related application and stabilize the power source using DC-DC boost converter, design of the circuit with peltier devices, dc-dc converter and the controller in order to reuse the wasted energy and supporting the car battery to generate more electric.

CHAPTER 2

LITERATURE REVIEW

2.1 A Brief History of Thermoelectric

In the year 1820, the study of thermoelectric began when a German physicist Thomas Johann Seebeck that shown in Figure 2.1 found a circuit at the junctions of two different types of metals with different temperatures would deflect compass magnet which is shown in Figure 2.2 at the next page. At the early stage, Seebeck believed this was due to magnetic polarization of dissimilar metals and termed it the thermo magnetism. However, it was quickly realized that a thermoelectric force induced an electrical current, which by Ampere's law deflects the magnet. This shows that an electric field was created between two metals due to the magnetism induced by the temperature differences and deflected the needle.



Figure 2.1 Thomas Johann Seebeck