UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOP AN OUTDOOR THERMOELECTRIC ENERGY GENERATOR

This report is submitted in accordance withthe requirement of the UniversitiTeknikal Malaysia Melaka (UTeM) for the Bachelor in Manufacturing Engineering Technology (Process and Technology) with Honours.

by

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FACULTY OF ENGINEERING TECHNOLOGY

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DESIGN AND DEVELOP AN OUTDOOR THERMOELECTRIC ENERGY GENERATOR**

SESI PENGAJIAN: **2015/16 Semester 1**

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DECLARATION

I hereby, declared this report entitled "Design and Develop An Outdoor Thermoelectric Energy Generator" is the results of my own research except as cited in references.

Signature **:………………………**

Name **:** MohdNazrin Bin MohdZaini

Date **:** 12/12/2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours. The member of the supervisory is as follow:

……………………………….

(ENCIK MOHD NAZRI BIN AHMAD)

ABSTRACT

Most of energy resources nowadays are applied fromthe non-renewable natural resources which can elimination of our natural resources. Besides that, energysources use at dangerous rate that surely can effect to the environment and also can increased the global warming. This project is aims to find the new energy that focuses on the camping activity where for charging communication tool and for mini lamp by using waste energy. The objectives of this project are design and develop an outdoor thermoelectric energy generator for camping purpose and analyses the efficiency of voltage generate by using TEG Module (Thermoelectric Generator Module).There are three components to generate the electric which are heat collector, heat sink and TEG (thermoelectric generator module).Method used in this project are idea generation, design concept, concept selection ,concept development ,detail design ,and prototype fabrication.Lastly, prototype is successfully fabricated through this project. Prototype has been tested to see the Voltage from thermoelectric generator by using Multimeter. By endof this project, the product was successfully fabricated with and able to generate electricity from thermo energy. From the experiment and results it be concluded that when temperature difference ΔT increased, the output voltage (V) also increasemeans value of voltage proportional to temperature, thensatisfied to Theory ofSeebeckeffect $V = \alpha (T_H - T_C)$.

ABSTRAK

Kebanyakansumbertenagapadapadamasakiniyang digunakandarisumbertenagaaslitidakbolehdiperbaharui,iajugamengancamsumbersem ulajadikita. Selainitu, sumbertenagadigunakanpadakadar yang berbahayajugapastibolehmemberikesanterhadapalamsekitardanjugabolehmeningkatk anpemanasan global. Projekinibertujuanuntukmencarisumbertenagabaru yang memberifokusterhadapaktivitiperkhemahan yang manabertujuanuntukmengecasalatkomunikasidanuntuklampu mini denganmenggunakansumbertenagaterpakai.Objektifprojekinijugaadalahmerekabentu kdanmembangunkanpenjanatenagatermoelektrikdi kawasanluaruntukkegunaanperkhemahandisampingmenganalisiskecekapanvoltanyan g terhasildenganmenggunakanalatpenjana TEG (modulpenjanatermoelektrik) .Terdapattigakomponenutamapenjanaanelektrikiaitupengumpulhaba, sink habadan TEG (modulpenjanatermoelektrik) .Kaedah yangdigunakandalamprojekiniadalahmencipta idea, rekabentukkonsep, pemilihankonsep, pembentukankonsep, rekabentukterperinci, danprototaipfabrikasi. Akhirsekali, prototaipberjayadirekabentukdenganjayanya.Prototaipjugamelaluipengujianterhadap keluaranVoltan yang terhasildaripenjanatermoelektrikdenganmenggunakanmultimeter. Padaakhirprojekini, produkinitelahberjayadirekadenganjayanyadanmampumenjanatenagaelektrikdaripada tenagatermo. Daripadaeksperimeninidankeputusaniamembuatkesimpulanbahawaapabilaperbezaan suhu ΔT meningkat, voltankeluaran (V) jugameningkatkanbermaknanilaivoltanberkadardengansuhu, makapuasTeorikesanSeebeck V = α (TH - TC).

This report is dedicated to my family. Thank you for your continuous support during my vital educational years. Without their patience, understanding and most of all love, the completion of this work would not have been possible.

To my beloved parents,

RasidahBintiLuddin

&

MohdZaini Bin Maarof

My siblings,

IrzuanaBintiMohdZaini

ShahiraBintiMohdZaini

NurakmaBintiMohdZaini

NurHazwaniBintiMohdZaini

NurAleaBintiMohdZaini

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"In The Name Of Allah, The Merciful, The Beneficent"

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbols	Parameter
A	Surface Area,m^2
I	Current flowing Through the leg pair or module, A
K	Thermal conductance
K*	*Coverage Factor
P	Power Generated by leg pair or module
Q	Heat rate , W
R	Electrical resistance of a module , Ω
R_{TH}	Thermal resistance, K/W
T	Temperature K or ºC
U	Uncertainty in a measured quantity, %
V	Voltage across a leg pair or module , V/K
ZT	Figure of merit, dimensionless
α	Seebeck coefficient, V
β	Temperature difference across the module
ΔT	Module efficiency , %
λ	Thermal conductivity, W/mk
π	Peltier coefficient, W/A
ρ	Electrical resistivily,Ωm
σ	Standard deviations in measurement , takes dimensions of measured quantity

CHAPTER 1
INTRODUCTION

1.0 Introduction

With world that rapidly developing nowadays, a large number of energy sources charged at a dangerous rate and it's certainly can cause the elimination of our precious natural resources. Moreover, there are a lot of the energy resources that applied today are non-renewable natural resources like petroleum. Because of that, a lot of focus has been applied to overcome the adverse impact on this environment. To overcome this problem, research on forming the new alternative energy can reduced our reliance on non-renewable forms of energy and therefore save the environment, has become more important than ever before.The demand for renewable sources of energy is increasing due to an elevated concern about the global warming, climate change and the decline of fossil fuel reserves. Thermoelectric developer is one of the alternate sources for the growth of power.

Generally most waste heat ideas involve the thermoelectric effect, where the voltage that created is based on the temperature difference. This approach has been limited by materials and the need for very high temperatures and gradients. Waste heat recovery, which aims to reduce the amount of waste heat and using it in either the same or different processes. "How much money will be saved?" The decision to recover waste heat depends critically whether the resulting energy cost savings exceed the cost of the installed waste heat recovery project being proposed. As a general rule of thumb, waste heat recovery projects may not be installed if the payback period is more than two or three years (Aziz, 2012).

As a measure against global warming, recovering waste heat and converting it into electrical energy is very effective. While there are various methods of recovering waste heat, much expectation is being entertained of the thermoelectric module that has no moving parts and that is capable of converting waste heat directly into electrical energy. Since discovery of the See beck effect, thermoelectric modules have been studied for more than 180 years. Nevertheless, the thermoelectric module has not become widespread yet. The major reasonfor this is the low efficiencies of conventional thermoelectric modules. In recent years, however, the characteristics of thermoelectric modules have improved so much that the prospect of thermoelectric power generation has rapidly become very bright. This paper describes the current status of development and the economics of thermoelectric modules for power generation.

The Advantages of Thermoelectric Generator:

a) Offer a potential in the direct conversation of waste energy to electric power irrespective of the cost of the thermal energy output.
b) Lower production cost
c) No moving part, thus quit in operation
d) Can be useful for heat recovery
e) Environment friendly

1.1 Problem Statement

The outdoor activity like camping is one of the best methods for people to release tension and spend time with their beloved family and friends. The usual problem when people joined a camping activity is the difficulty to get electric source to charge their devices like phone or mini lamp. The electrical generating appliances used nowadays are practical but not nature-friendly as it causes air pollution from the combustion of fuel. To overcome the problem, there is an alternative to generate electricity from the wasted heat of cooking stove by using concept thermoelectricity.

1.2 Objective of Project

The objectives of this project are:

i. To design and develop an outdoor thermoelectric energy generator for camping purpose.
ii. To analyse the efficiency of voltage generate by TEG module (thermoelectric generator)

1.3 Scope of Study

The scopes of this project are:

i. Designing and fabricate an outdoor thermoelectric energy generator attached on cooking stove for camping purpose.
ii. Use for rechargeable appliances like hand phone or mini lamp (5V DC conversation).
iii. Beta prototype(functioning prototype) of thermoelectric generator for outdoor activity.

Table 1.0:Gant Project Planning

Listdown the main activity for the project proposal. State the time frame needed for each activity.

Project Activity	2015/1																				2015/2																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	BP Briefing							Mid Term Break							Study Week		Final Semester Examination		Semester Break									Mid Term Break							Study Week	Final Semester Examination		
Project title discussion		■																																				
BP Proposal			■																																			
Introduction			■																																			
Background of project				■																																		
Identify problems				■																																		
Objectives and scopes				■																																		
Literature review				■																																		
Design heat collector					■	■			■	■																												
Presentation PSM 1													■	■																								
Project schedule development																					■																	
Result analysis																							■	■														
Result comparison																									■													
Discussion																										■												
Recommendation																										■			■									
Conclusion																														■	■							
Presentation PSM 2																																	■					

1.4 Project Planning

Table 1.0shows the progress for the whole semester 1 of the Final Year Project (FYP). Weekly meetings with supervisors have been done on Wednesdays to understand the project as well as to manage the weekly schedule.

For the first week of semester 1, a discussion with supervisor is done to discuss about the project as shown in Figure 1.1. Then, it's continued with searching the related journal to get more understanding about project and also started to write the literature review. The purpose of the literature review to establish a theoretical framework for research project and it is reported in chapter 2 of this research. Identify the problem of project is important to ensure that objectives of the project are achieved at the end of the FYP.

Chapter 3 or project methodology describes the particulars of the materials and component used in the present work and the procedure for fabricate with the best concept and design selected. Process screening is been done in this chapter to select the best concept.

Chapter 4 explained about the result of project. Discussion for all the scope of study which is the designing and fabricate an outdoor thermoelectric energy generator, using for rechargeable appliances and Beta prototype (functioning prototype) of thermoelectric generator for outdoor activity.

1.5Project Methodology

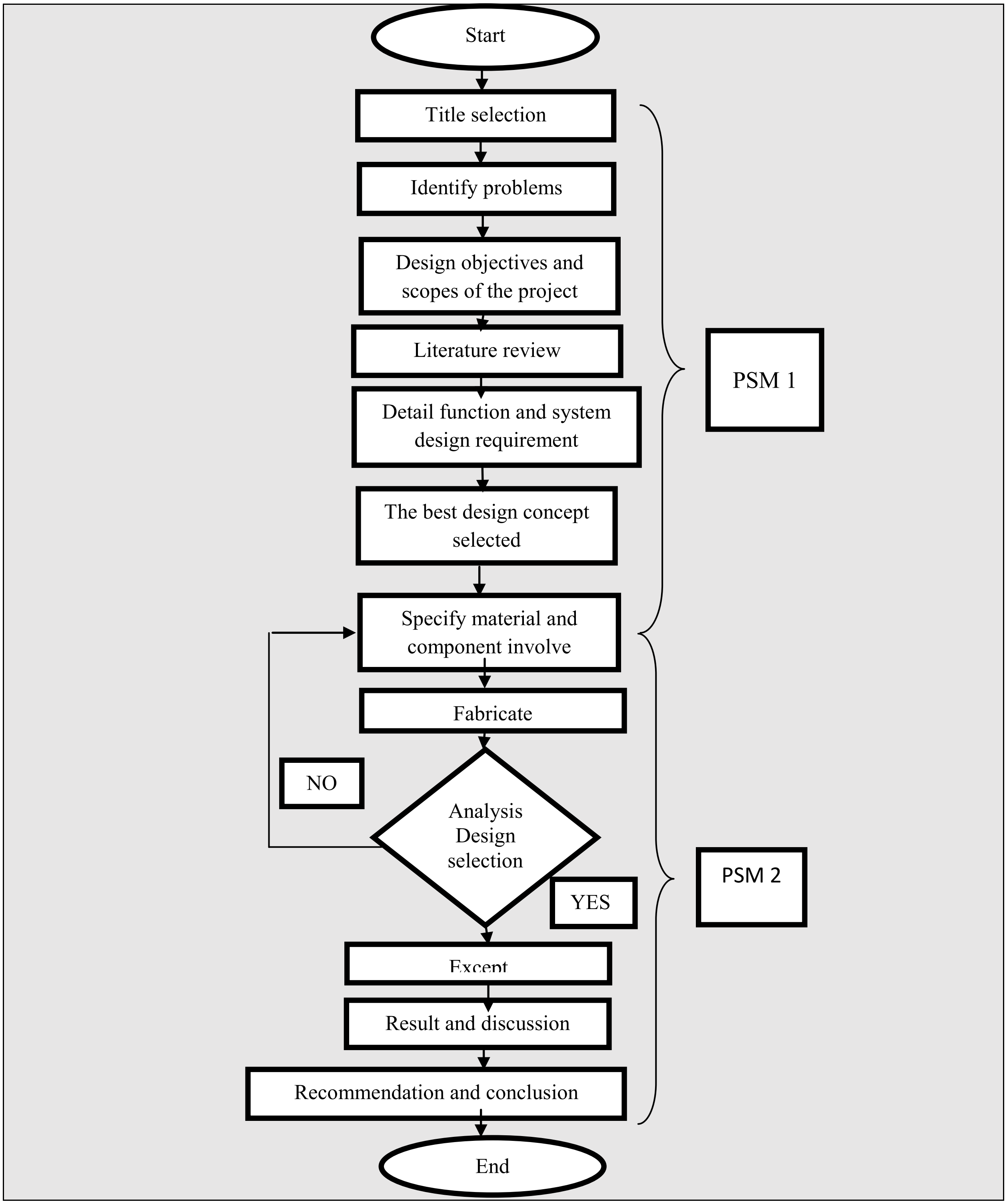

Figure 1.1: Flow Chat

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter would generally discuss aboutheat transfer mechanisms and performance optimization of thermoelectric generators (TEG). Related themain objective of this project. This project recommended the further studies to measure the efficiency thermoelectric system idea to camping stove cooking.

2.1 Thermoelectric

Thermoelectric generators, or TEG, are solid state energy deviceswhich convert heat directly into electricity by means of the thermoelectric effect. The thermoelectric effect is the result of a combination of other influences: the Seebeck effect, Thomson effect and Peltier effect, the Joule effect and the Fourier effect.A thermoelectric module is clamped between a heat source and a heat sink. Heat flows from the heat source through the module and is dissipated by the heat sink, and electricity is produced by the module. The thermoelectric module consists of pairs of p–n thermoelements. The positive (p-type) and negative (n-type) doped semiconductor elements are connected electrically in series and thermally in parallel.The working principle is depicted in Figure 2.1(S.M O Shaughnessy, 2012)

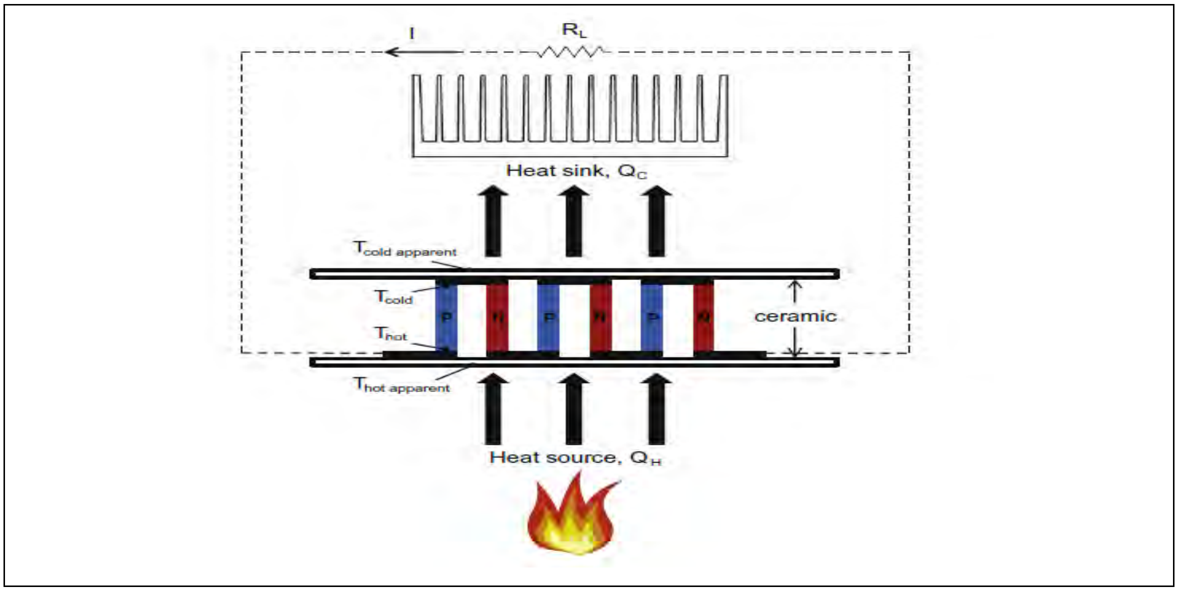

Figure 2.1: Thermoelectric Power Generation (S.M O Shaughnessy, 2012)

A thermoelectric module is clamped between a heat source and a heat sink. Heat flows from the heat source through the module and is dissipated by the heat sink, and electricity is produced by the module. The thermoelectric module consists of pairs of p–n thermo-elements. The positive (p-type) and negative (n-type) doped semiconductor elements are connected electrically in series and thermally in parallel. Initially, the conductors in the module possess a uniform distribution of charge carriers. However, the heat input to the module, Heat source QH, creates a temperature differenceacross the p–n thermoelements. The Seebeck effect is described by Rowe. The free carriers at the hot end have greater kinetic energy and diffuse to the cold end. The accumulation of charge results in a back emf which resists further flow of charge. If the temperature difference across these junctions is maintained, an open circuit voltage V is generated according to:-

$V = \alpha (T_H - T_C)$ Equation 2.1

Where α is the Seebeck coefficient and Th and Tc are the ‘hot’ and ‘cold’ junction temperatures. The Seebeck coefficient is a thermoelectric material property. Several thermoelectric materials are available for use in generators. Rowe describes the 'worth' of thermoelectric materials, expressed by a quantity Z, known as the:

$$Z = \frac{\alpha^2 \sigma}{\lambda} = \frac{\sigma^2}{\rho \lambda} \text{Equation2.2}$$

Where λ is the thermal conductivity, σ the electrical conductivity, and ρ is the electrical resistivity(Minnich A. J,2009).

2.2 Background and Theory

Thermoelectric device are essentially solid state device that can change energy from heat to electricity or the other way around. Devices are regularly made up of semiconductor materials, the most widely recognized being bismuth telluride. A regular arrangement of a thermoelectric module consist of numerous leg sets made of semiconductor pellets, joined together utilizing contact tabs made of high conductivity materials(Sachit,2013)

2.2.1 Seebeck Effect

The principle behind the working of the thermoelectric module is the Seebeck effect. In 1821 Thomas Johann Seebeck observed that when two dissimilar metals with junctions at different temperatures are connected in a circuit, a magnetic needle would be deflected. Seebeck initially attributed this phenomenon to magnetism. However, it was quickly realized that it was an induced electrical current that deflects the magnet in a thermoelectric module, the two dissimilar conductorsare connected electrically in series and thermally in parallel. When the two junctions are maintained at temperatures THandTc respectively, and TH>Tc , an open circuitelectromotive force (v) is developed between the junctions, as seen in Figure 2.2(Sachit, 2013).

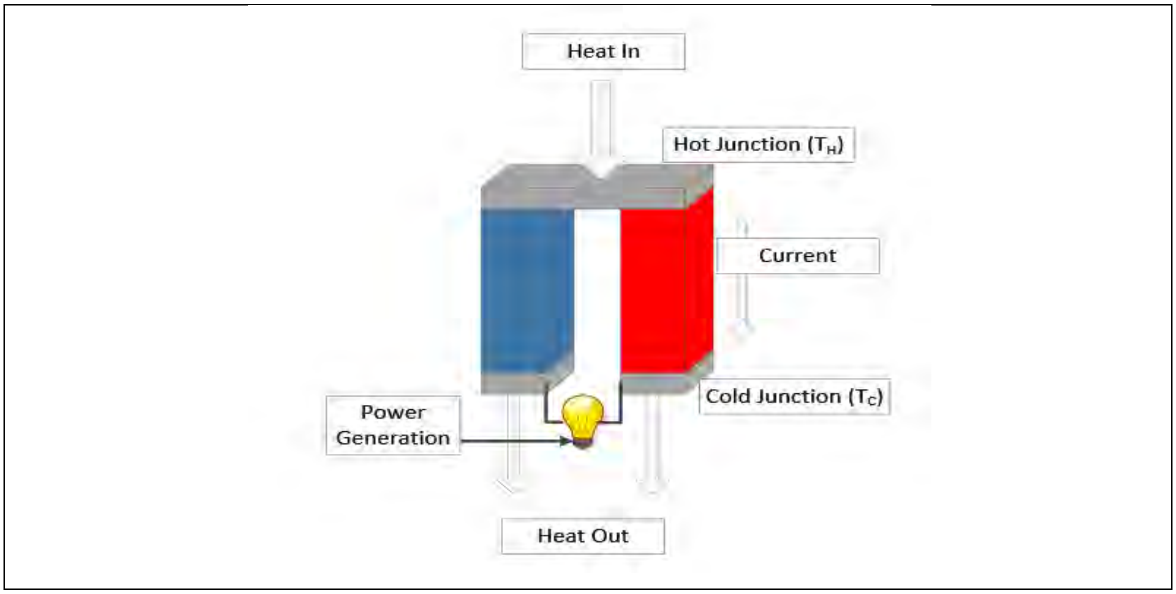

Figure 2.2:Developed Between The Junctions (Satchit, 2013)

The voltage produced is proportional to the temperature difference between the two junctions.

This is given by:

$$V = \alpha \, (T_H - T_C) \qquad \text{Equation 2.1}$$

The proportionality steady, α, is the different between the Seebeck coefficients of the two materials shaping the intersection. This is known as the general Seebeck coefficient, and frequently alluded to as the thermoelectric force or thermo power. The Seebeck voltage does not dependon the conveyance of temperatures along the material between the intersections. This marvel is what is utilized to quantify temperatures utilizing thermocouple (Sachit,2013).