DEVELOPMENT OF FLARE GAS GENERATION UNIT BASED ON THERMAL ENERGY CONVERSION

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BACHELOR OF ELECTRICAL ENGINEERING TECHNOLOGY

(INDUSTRIAL POWER)

2020

MUHAMMAD IRFAN HAZIM B.Eng IN ELECTRICAL ENGINEERING TECHNOLOGY 2020

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Muhammad Irfan Hazim b Mohd Yurizulkifli

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This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

Faculty of Electrical and Electronic Engineering Technology

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2020

DECLARATION

I hereby, declare this report entitled " Development of Flare Gas Generation Unit Based on Thermal Energy Conversion " is the result of my own research except as cited in the references.

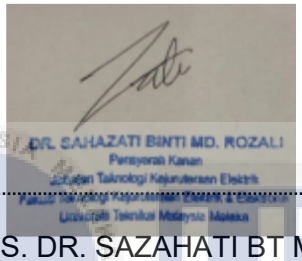
Signature : 

Name : MUHAMMAD IRFAN HAZIM B MOHD YURIZULKIFLI

Date : 11/2/2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industial Power) with Honours. The members of supervisory are as follow:

Signature : 

Supervisor Name : TS. DR. SAZAHATI BT MD. ROZALI

Date : 15/2/2021

DEDICATION

To my beloved parents

To my supervisor, Dr. Sahazati Binti MD. Rozali

To my co-supervisor, En Ezwan Azrin Bin A Rashid

To my lecturers

And not forgetting to all my friends.

ABSTRACT

Recently, an increasing concern of environmental issues of emissions, in particular global warming and the limitations of energy resources resulted an extensive research into novel technologies of generating electrical power. Thermoelectric power generators emerged as a promising alternative green technology due to their distinct advantages. Thermoelectric power generation offer a potential application in the direct conversion of waste-heat energy into electrical power where it is unnecessary to consider the cost of the thermal energy input. The application of this alternative green technology in converting waste-heat energy directly into electrical power improve the overall efficiencies of energy conversion systems. In this research, a background on the basic concepts of thermoelectric power generation is presented and recent patents of thermoelectric power generation with their important and relevant applications to waste-heat energy are reviewed and discussed. In the actual operation, the electrical connected thermoelectric modules are operated under temperature mismatch conditions and decreased the power output causes due to the inhomogeneous temperature gradient distribution on heat exchanger surface. In this study, an individual module test system and a test bench is carried out to test and analyze the impact of thermal imbalance on the output electrical power at module and system level. Variability of the temperature difference and clamping pressure are also tested in the individual module measurement. The system level experimental results clearly describe the phenomenon of thermoelectric generator's decreased power output under mismatched temperature condition and limited working temperature. This situation is improved with thermal insulation on the modules and proved to be effective. This residual thermal energy can be converted into usable electricity using thermoelectric generator (TEG), which are manufactured cells with semiconductor materials employing the Seebeck effect. When recovering the waste heat in the exhaust ducts using TEG, the efficiency of electrical machines is increased because the same amount of fuel input generates more power or less intake of fuel has the same amount of the generated electric energy and thus reduce air pollution

ABSTRAK

Baru-baru ini, meningkatnya keprihatinan terhadap isu-isu pelepasan alam sekitar, khususnya pemanasan global dan keterbatasan sumber tenaga telah menghasilkan penyelidikan yang luas terhadap teknologi baru untuk menghasilkan tenaga elektrik. Penjana termoelektrik power telah muncul sebagai teknologi hijau alternatif yang menjanjikan kerana kelebihannya yang berbeza. Penjanaan tenaga termoelektrik menawarkan aplikasi yang berpotensi dalam penukaran langsung tenaga haba-buangan menjadi tenaga elektrik di mana tidak perlu mempertimbangkan kos input tenaga termal. Penerapan teknologi hijau alternatif ini dalam menukar tenaga haba-sisa secara langsung untuk tenaga elektrik meningkatkan kecekapan keseluruhan sistem penukaran tenaga Dalam penyelidikan ini, latar belakang konsep asas penjanaan tenaga termoelektrik dinyatakan dan paten terbaru penjanaan tenaga termoelektrik dengan aplikasi penting dan relevan mereka untuk tenaga haba sisa dikaji dan dibincangkan. Dalam operasi sebenar, modul termoelektrik bersambung elektrik dikendalikan dalam keadaan ketidakcocokan suhu dan penurunan output daya disebabkan oleh taburan kecerunan suhu yang tidak homogen pada permukaan penukar haba. Dalam kajian kes ini, sistem ujian modul individu dan bangku ujian dijalankan untuk menguji dan menganalisis kesan ketidakseimbangan terma terhadap kuasa elektrik output pada tahap modul dan sistem. Pemboleh ubah perbezaan suhu dan tekanan pengapit juga diuji dalam pengukuran modul individu. Hasil eksperimen tahap sistem dengan jelas menerangkan fenomena penurunan output kuasa penjana termoelektrik di bawah keadaan suhu tidak sepadan dan suhu kerja yang terhad. Keadaan ini ditingkatkan dengan penebat haba pada modul dan terbukti berkesan. Tenaga termal sisa ini dapat ditukarkan menjadi elektrik yang dapat digunakan menggunakan generator termoelektrik (TEG), yang merupakan sel yang dihasilkan dengan bahan semikonduktor0menggunakan kesan Seebeck. Semasa memulihkan sisa haba di saluran ekzos menggunakan TEG, kecekapan mesin elektrik meningkat kerana jumlah input bahan api yang sama menghasilkan lebih banyak tenaga atau kurang pengambilan bahan bakar mempunyai jumlah tenaga elektrik yang dihasilkan yang sama dan dengan itu dapat mengurangkan pencemaran udara.

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Last but not least, from the bottom of my heart a gratitude to my beloved parents, Mohd. Yurizulkifli Bin Abd. Wahid and Zalina Binti Ardi for their encouragements and who have been the pillar of strength in all my endeavors, endless support, love and prayers. Finally, thank you to all the individual(s) who had provided me the assistance, support and inspiration to embark on my study

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LIST OF SYMBOLS AND ABBREVIATIONS

TEG	-	Thermoelectric Generator
GW	-	Giga Watts
WEA	-	World Energy Assessment
GEA	-	Geothermal Energy Association
PV	-	Photovoltaic

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Electricity is one of the main energies in daily life. The common source of electricity is fossil fuel. Nowadays, there is a lot of wasted energy that does not been used up and recognise its potential that actually provide with useful of electricity. Due to this extinction of resources, thermal energy had been recognised as one of the largest sources of renewable energy according to the World Energy Assessment [WEA, 2000].

Compared with solar and wind systems, geothermal energy has many advantages that helps in improvise in this area, including being impervious to weather changes, having a stable base load, and high thermal in efficiency (for high temperature geothermal resource) [Mary H. Dickson, 2013]. However, the total capacity of installed geothermal power are left behind solar and wind as the installed power of PV and wind were 70 and 240 GW, respectively whereas the total geothermal power installed in the world was about 11.2 GW as of May 2012 [REN21. 2019]. According to Geothermal Energy Association (GEA), the average annual growth rate of geothermal power is about 2%, while that of PV is about 58% during 2006 and up to 74% in 2011[GRC Transactions, Vol. 37, 2013]. Throughout this statements, oil and gas fields has been circled as the best field that can produce large amount of production for geothermal energy compared to the others sector of field [Greenhouse Gases from Geothermal Power Production, 2016].

Over 200'C of thermal heat that produced by oil and gas fields in every second which actually proved that it is the best consumer of energy production due to the constant temperature of heat. Since 1821, many researches have investigated the application of thermoelectric materials and the development of thermoelectric power generator using car exhaust heat had been started over 2007 and the maximum power output reached is 255 W [Transactions - Geothermal Resources Council 37:733-737 , January 2013]. Due to this, it had been advanced into thermoelectric conversion exhaust system for the light truck to reduce the usage of the electricity consumption directly from the batteries.

In this study, a power generation system using thermoelectric generator modules and conductor materials had been used to measure the output power at different temperature gradients and other conditions. The efficiency of TEG modules manufactured and few conductors with different materials will be tested to make sure the TEG used is compatible to the thermal energy produced. The cost of the power generator using TEG technology and conductor technology was estimated and the results show that conductor technology was competitive to PV technology.

1.2 Problem Statement

Throughout this globalisation, renewable energy can't only depend on solar and wind energy only as the demand in electricity which increasing throughout the years. In order to fulfil the demands and needs for electricity, this form of energy must be featured. Otherwise, the energy consumption will not able to accommodate the demand of the consumer. During 2015, according to World Bank, the electric power consumption and demand in Malaysia is 4246.67 MW per year including commercials and industrials needs [GRC Transactions, Vol. 37, 2013].. Thus, this project is an alternative to solve this problem due to the increasing demand throughout the year.

1.3 Research Objective

The objectives of this project are as follow:

a) To develop a prototype of flare gas generation unit that capable to produce desire output needed.

b) To determine the suitable types of TEG and conductor materials by power testing experiment.

c) To analyse the functionality of TEG module and conductor materials by dimensionless figure of merit and its value with temperature.

d) To verify thermal design of the flare conducting media by using MATLAB®

1.4 Scope of Research

The flare gas generation unit is develop by using conductor materials such as aluminium wire and iron wire as the cooling factor will be a mini radiator. In order to conduct the test, TEG and conductor materials is used. The analysis for functionality tested by different types of materials to achieve the maximum output desired within the different between temperature concentrations. The concept verify by using MATLAB® to prevent from any harm occur during installation process. This device is solely built to support large amount of street light and not for industrial or commercial used. This device is useful to support the green technology of renewable energy in Malaysia.

1.5 Organisation

This project basically focus on the development of thermoelectric generator to install at the flare gas which commonly can be found at every oil and gas industries. The scope of this project is basically divided into two parts which is software and hardware.

In this project, a thermoelectric generator of aluminium wire and iron wire is used as the main input of the power source of the street lights. The function of thermoelectric generator is to convert thermal energy into electrical energy in order to be supply to the street light and the storage for the rechargeable battery. Hence, a 6V rechargeable battery is added in the circuit as an emergency storage or backup storage when total shut down occur.

A-type female USB port is used in the circuit so it can be connected to the A-type male port from the cable. The USB port is used to supply the voltage and current up to 5V and 450mA to the device which connected to the USB port. It is used to connect the LED appliances which act as the street lights. This prototype for this project need to work as the function listed above and the design definitely designed under the considerable of safety.

1.6 Conclusion

Based on the objectives previously presented and on the approach proposed before, this thesis is made up of five (5) chapters, which contents are summarized as follows:

- Chapter 1. Introduction. This chapter presents the background of the study, research problems, objectives, scopes, contributions and significance of the research.
- Chapter 2. Literature review. This chapter starts with brief overview of current energy efficiency and sustainability issues and challenges in today's power distribution system related. A brief summary of the modern power distribution system, followed by its network configuration and load characteristics. Then, this chapter presents various literatures on references on characterization of distribution network/feeders based on RN concept. Later, this chapter presents overview of TL in distribution network and

discusses various methodologies to estimate TL in the network. Also, a brief discussion on the economics of energy is also presented.

- Chapter 3. Methodology. This chapter presents the methodology that has been developed to undergoes .
- Chapter 4. Conclusion and future works. This chapter summarizes the main conclusions as well as achievements of the work undertaken in this research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter gives a review of a Flare Gas Generation Unit for Oil and Gas industries. The main source of the study was taken from journals, conference paper, books, articles, and websites. Each source is chosen according to the relevance of project scope.

2.2 World Energy Consumption

World's Energy Consumption Natural resources such as the wind and sun are effectively utilized to produce energy. Since these types of resources are theoretically infinite, it offers attraction to be utilized and developed extensively. In 2008, about 19% of primary energy for the world's consumption is sourced from renewable resources. Large hydropower constitutes the highest percentage followed by biomass. Modern technologies like wind, solar, geothermal and other technologies produce very less of the world's demand. Figure 2.1 and 2.2 highlight the present renewable energy scenario. (Renewable Energy Emission, 2010)