UNIVERSITI TEKNOLOGI MARA

THE EFFECT OF DIFFERENT COOLING METHODS FOR POWER GENERATION IN PARABOLIC SOLAR DISH CONCENTRATOR USING THERMOELECTRIC GENERATOR

ANEURIN NANGGAR ANAK NYANDANG

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Mechanical Engineering)

College of Engineering

November 2022

ABSTRACT

The overuse of fossil fuels over the years has become a worldwide topic. The spike in crude oil prices and the increase of greenhouse effects from burning fossil fuels is the most discussed issues regarding the usage of fossil fuels. Hence, scientists and researchers all over the world has great interest to seek for an alternative. The alternative that can reduce the usage of fossil fuels is renewable energy. Renewable energy is a promising energy because it is clean and infinite. Solar energy, as one of the many renewable energies, is the most simple and available abundantly. For power generation, the solar energy from the sun is collected and converted into electricity. There are two ways to convert the solar energy into electricity: solar thermal and solar photovoltaic (PV) systems. Solar thermal technologies are a promising technology because they recover the heat energy from solar radiation. Parabolic Dish Collector (PDC) is one of the many types of collectors available to harness the sun. In this research, the use of PDC is hybridized with a Thermoelectric Generator (TEG), then referred to as Solar Thermoelectric Generator (STEG). STEG has been thoroughly explored because of its ability to produce both electricity and heat simultaneously. TEG is a solid-state device that can convert the thermal energy into electricity directly. The main objective of this research is to evaluate the performance of single TEG for different heating condition with various cooling methods for best power generation. Hence, this thesis investigates the possibilities of power generation from PDC using TEG under various cooling methods. The introduction of different cooling methods shows a distinctive effect on the performance of TEG. The research works are conducted with two tests: TEG characterization test (single and double) and STEG application. Mathematical modelling is developed to investigate the performance of TEG in the characterization test. In addition, this thesis also explains the design of STEG used. The experimental tests setup and procedures are thoroughly explained. It is concluded that water-cooled cooling method is the most effective cooling method for power generation in STEG application, that is, 32% higher compared to air-cooled cooling method with finned heat sink. The effect of thermal variation on the performance of TEG is also thoroughly explained in this thesis. The demonstrated system has the potential to generate electricity using the sun as the main energy source at low cost and great reliability and shows it is an innovative design to generate electricity from PDC using TEG.

ACKNOWLEDGEMENT

First and foremost, praise be to God for His blessings that has been given to me throughout this journey. It has been an uphill battle for me.

I would like to express my gratitude to my main supervisor Ir. Ts. Dr. Baljit Singh A/L Bhathal Singh and my co-supervisor Dr. Muhammad Fairuz bin Remeli for their guidance and support in completing this thesis. Their expertise in the field has indeed helped me to complete this thesis with new knowledge and new experience that will benefit me for my future endeavours.

Also, I would like to express my gratitude to the lab technicians for their tremendous help in completing my research works. They have been providing me all the necessities for me to carry out my research works and have provided me some insights to make my research works more effortless.

Not forgetting my parents, my family, and my fiancé, I would like to thank them for their moral support and encouragement throughout the duration of my studies. This entire journey is dedicated entirely for them.

Finally, I would like to give thanks to all my friends who took great care of me and encouraged me to keep moving forward while completing this journey. Their moral supports have also given me strengths to complete this journey.

TABLE OF CONTENTS