UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT AND PERFORMANCE ANALYSIS OF A DOME-GLASS SOLAR THERMOELECTRIC GENERATOR

AHMAD ZUHAIRDI BIN NOH

MSc

June 2020

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Ahmad Zuhairdi Bin Noh
Student I.D. No.	:	2014382399
Programme	:	Master of Science (Applied Physics) – AS760
Faculty	:	Applied Sciences
Thesis Title	:	Development and Performance Analysis of a Dome-Glass Solar Thermoelectric Generator
Signature of Student	:	
Date	:	June 2020

ABSTRACT

Thermoelectric technology can be classified into five different fields, and one of them is extracting energy from the solar radiation. Basically, solar energy has multiple ways of extraction, and the most effective method is by combining photovoltaic panel with a thermoelectric module (PV-T). In term of industrial production, the evacuated tube and flat plate solar-thermal electric generator are dominating the market instead of PV-T. However, it can be seen that the current design from both type of the generator is mostly focused on extracting heat instead of preserving it. This led to the condition where the thermal-generator loss its efficiency under a certain environment for example cloudy day. The design of using a dome-glass for a glass cover in the thermoelectric generator was proposed in order to tackle the problem. It was reported that the usage of dome-design is able to boost energy efficiency by 20 %. This research was aiming to develop this dome-glass design, collecting the data of its performance, and at the same time constructing an adjustable mathematical model for future use. The prototype for the following design was fabricated in this study and tested under different environment. A mathematical model for the prototype was created using MATLAB to monitor the performance of heat transfer in single dimensional form followed by 2D and 3D visualization using ANSYS. The variables used in the default model were taken from the available literature related to the design. The prototype was tested under both controlled and actual environments to obtain actual data of the thermal and electrical performance of the prototype. Under the controlled condition where the irradiance was 1000W/m^2 and the ambient temperature of 23°C, the steady-state temperature achieved by the prototype was 63.64°C and it took 25 minutes for the prototype to achieve time constant, τ. The theoretical results of a plate temperature from the mathematical model give off a deviation of ±0.86 (2%) from the actual value under a controlled environment. Meanwhile, a plate temperature under real environment shows a deviation of the results in range of 0.5% to 24.5% at cloudy sky environment and 0.5% to 20.9% under clear sky environment. For thermal efficiency, the prototype shows a performance of 4% to 20% while at the same time the electrical efficiency is able to spike up to 0.4%. These results indicate that the prototype produced in this study is at par with some of the flat-plate thermoelectric generator that used a sun tracker and a flat glass as a glass cover. As a conclusion, results from this study can be used as a reference for any study on the solar thermoelectric generator with a design based on dome-glass. Since the standard acceptable deviation for the predictive model is below 30 %, the mathematical model created from this study can be used for future development. The mathematical model generated from this study also can be modified and improved further to suit the need for a future researcher who wishes to study the dome-glass solar thermoelectric generator.

ACKNOWLEDGMENT

Firstly, Alhamdulillah thank you Almighty God for showing and guiding me since the beginning of my master journey until the end. He the one who introduced me to this journey and He is the one who guides me until where I am now. Second, the highest gratitude was given to my parents who are very supportive in term of financial and motivation. Without them and their dua', I will never finish this journey. So, this work is dedicated to both of you with love. Third, biggest appreciation goes to my supervisor PM Dr. Mohd Nazari Abu Bakar for his patience and guidance along this journey. Without him, I may have lost my way and quit this study. He also provides me a lot of idea in developing the prototype while at the same time providing a facility for analytical work. Fourth gratitude goes to all lab staff who allow me to borrow an apparatus from the lab under their supervision. Fifth gratitude belongs to Mr. Mohd Lias Kamal, chemistry lecturer in UiTM Arau who always giving me a motivation to move forward. Final gratitude was given to all friends who involve either directly or indirectly during this study. Some of the idea used in this study was inspired by many of my friends. That includes Mr. Saifuldin, Mr. Faizal, Mr. Azmi, Mr. Nazzery, Ms. Syazwani, Mdm. Hafizah, Mdm. Farhana, and Mdm. Siti Noraisah.

TABLE OF CONTENT