UNIVERSITI TEKNOLOGI MARA

PERFORMANCE ANALYSIS OF A HYDROGEN PROTON EXCHANGE MEMBRANE FUEL CELL PROPULSION SYSTEM FOR UNMANNED AERIAL VEHICLE

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of the requirements for the degree of
Master of Science

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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 result 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.

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ABSTRACT

The report documents the study on a hydrogen proton exchange membrane (PEM) fuel cell powered unmanned aerial vehicle (UAV) named Kenyalang-1. Common aircraft utilize internal combustion engines (ICE) as main power source for the propulsion system. However, ICE imposes negative impact towards the environment due to the pollution produced through carbon emission, initiating green house effect, global warming, and health problems. Researchers have started to develop interest on the possibilities of using alternative energies to replace ICE aircraft propulsion system. Due to the relatively new nature of the technology, there is a need for a research on the development of a fuel cell electrical propulsion system. The objectives of this project are to design and to develop a fuel cell propulsion system that operates using a 500 W hydrogen PEM fuel cell as the main power generator for a UAV. The research is important to determine the capability of the propulsion system to power a custom designed and built 5-meter wingspan UAV that acts as a technology demonstrator. The propulsion system was designed in two configurations, fuel cell and hybrid. The system consists of a fuel cell (main power supply), 2-cell lithium polymer battery (hybrid), electronic speed controller, a brushless direct current motor and a propeller. Mathematical model simulation is designed to predict the performance outcome from the system while experimental approach to validate the simulation is done through two different methods; ground-based static test in the lab and actual test flight at an outdoor location. The performance from the flight tests shows that both configurations were capable to produce sufficient power, thrust, and speed for the aircraft to fly successfully. The maximum power of 514.49 W was achieved for the fuel cell system and 862.45 W was achieved for the hybrid system. The maximum speed of the aircraft was 19.4 meters per second with a maximum altitude achieved at 90 meters. The simulation and experimental comparison shows that the simulation result follows the same trend as the experimental; however some errors were identified showing slight inaccuracies between both results. It can be concluded that the objective of this study is achieved through the development of a 500 W fuel cell powered UAV that was flight tested and a mathematical model has been developed as a method of prediction. This project is beneficial to the society since the UAV can be utilized for air surveillance monitoring, remote sensing, aerial photography, scientific research, and also transportation.

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