UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EVALUATING ELECTRIC BOAT WITH INBOARD JET PROPULSION FOR PATROL VESSEL

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B091910372

Bachelor of Mechanical Engineering Technology (BMMV) with Honours

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A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (BMMV) with Honours

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2023

DECLARATION

I declare that this Choose an item. entitled " Evaluating Electric Boat With Inboard Jet Propulsion For Patrol Vessel " is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Date : 20 JANUARY 2023

APPROVAL

I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (BMMV) with Honours.

Signature : 

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Date : 20 JANUARY 2023

DEDICATION

“In particular, I would like to thank my father, Mr. Wong Leng Sieng, my mother, Mrs. Ling Hie Kee, and the rest of my family for their support, encouragement, and advice. Additionally, I would like to thank the Faculty of Mechanical and Manufacturing Engineering Technology at Universiti Teknikal Malaysia Melaka (UTeM) for providing me with the opportunity to gain knowledge and evaluate the future possibilities for the renewable energy fulfilled by citizens. With the aid and assistance of my supervisor at Universiti Teknikal Malaysia Melaka and close relatives who assisted directly or indirectly in the compilation of this report, I would like to express my gratitude. Please accept my sincere appreciation.”

ABSTRACT

As a result of the rising demand for fuel energy and the impending depletion of fossil fuels, the majority of boat users are now burdened by greater fuel costs. Renewable energy is perhaps the greatest answer to this issue. Therefore, these programs aimed to resolve the issue by substituting fossil fuel energy with sustainable solar energy. This project involves the design and construction of a solar-powered boat propelled by an electric motor supplied by photovoltaic (PV) panels and using solar energy. The PV panels must be fitted and installed on the vessel without impairing the ride quality. This is a cost-effective means of recreation or travel across relatively small distances. The suggested solar powerboat would consist of solar panels (photovoltaic cells) as sunlight collectors that operate as the power generator, which will be supplemented by a battery as storage power for the boat and a direct-current (DC) motor that will replace the gasoline engine. The technology utilizes a solar panel, rechargeable battery, and electric motor to construct a solar-powered electric watercraft. A solar collector is attached to a rechargeable battery for collecting solar energy and converting it to electrical power for delivery to the battery for recharging. A rechargeable battery is linked to an electric motor to provide the motor with electrical power. The charging procedure will be controlled by a PWM-operating solar charger controller. The whole system will begin by converting sunlight to energy, which will then be transferred to the battery. The load that employed the dc motor will thereafter be operational. Both charging and operating the load will occur simultaneously. In addition, this solar boat is designed to limit and economize the amount of power used by its electric engine, optimize the value of solar energy in citizen lives without wasting it, and subsequently expand the system for commercial usage. This solar power technology allows human to cut our gasoline use. Additionally, this strategy reduces the air pollution caused by the gasoline engine. In conclusion, solar energy will be used to power the solar-powered electric boat, which will be fed by photovoltaic panels.

ABSTRAK

Sebagai hasil dari permintaan tenaga bahan bakar yang meningkat dan penghabisan bahan bakar fosil yang akan datang dalam masa depan, pengguna kapal majoriti sekarang memerlukan kos bahan bakar yang amat tinggi. Tenaga yang boleh diperbaharui mungkin merupakan solusi terbaik untuk isu ini. Oleh itu, projek ini bertujuan untuk menyelesaikan masalah dengan menggantikan tenaga bahan bakar fosil dengan tenaga suria yang berterusan untuk setiap hari. Projek ini melibatkan reka bentuk dan pembinaan kapal bertenaga suria yang dikerjakan oleh motor elektrik yang dibekalkan oleh panel fotovoltaik (PV) yang menggunakan tenaga suria. Panel PV mesti dipasang di kapal tanpa menjejaskan kualiti perjalanan. Ini adalah kaedah rekreasi atau perjalanan yang menjimatkan jarak yang agak kecil. Kapal tenaga suria yang dicadangkan terdiri daripada panel suria (sel fotovoltaik) sebagai pengumpul cahaya matahari yang beroperasi sebagai penjana kuasa, yang akan dilengkapi dengan bateri sebagai daya penyimpanan kapal dan motor arus terus (DC) yang akan menggantikan atau mempermudahkan enjin petrol. Teknologi ini menggunakan panel solar, bateri yang boleh dicas semula, dan motor elektrik untuk membina kapal air elektrik berkuasa solar. Pengumpul solar dipasang pada bateri yang boleh dicas semula untuk mengumpulkan tenaga suria dan menukarnya menjadi tenaga elektrik untuk penghantaran ke bateri untuk dicas semula. Bateri yang boleh dicas semula dihubungkan dengan motor elektrik untuk memberi motor elektrik kuasa. Prosedur pengecasan akan dikendalikan oleh pengawal pengecas solar yang beroperasi PWM. Keseluruhan sistem akan dimulakan dengan menukar cahaya matahari menjadi tenaga, yang kemudian akan dipindahkan ke bateri. Beban yang menggunakan motor DC selepas itu akan beroperasi. Kedua-dua pengisian dan operasi beban akan berlaku secara serentak. Di samping itu, kapal solar itu bertujuan untuk mengehadkan dan menjimatkan penggunaan tenaga motor elektrik, mengoptimumkan nilai tenaga solar dalam kehidupan orang ramai tanpa membazirnya, dan seterusnya mengaktifkan sistem untuk kegunaan komersial. .Teknologi tenaga suria ini membolehkan manusia mengurangkan penggunaan petrol warganegara. Selain itu, cara ini boleh mengurangkan pencemaran udara dan juga suara yang disebabkan oleh enjin petrol. Kesimpulannya, tenaga suria akan digunakan untuk menggerakkan kapal elektrik bertenaga suria, yang akan dijanakan oleh panel fotovoltaik.

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LIST OF SYMBOLS AND ABBREVIATIONS

PWM	-	Pulse width modulation
IPS	-	Integrated power system
PV	-	Photovoltaic
DC	-	Direct-current
AC	-	Alternating-current
CO_2	-	Carbon dioxide
NO_2	-	Nitrogen dioxide
SO_2	-	Sulphur dioxide
kg/m^3	-	Kilogram per meter cube
w/m^2	-	Watt per meter square
SLI	-	Staring lights ignition
Voc	-	Open circuit voltage
Ioc	-	Short circuit current
Imp	-	Maximum power current
Vmp	-	Voltage
NOCT	-	Nominal operating cell temperature
SRC	-	Standard rating circumstances
Tc	-	Cell temperature
P/D^2	-	Power over density square
CFD	-	Computational fluid dynamics
CAD	-	Computer-aided design
E_{load}	-	Overall energy demand
P_{prop}	-	Propulsion power
E_{serv}	-	Service energy
E_{pv}	-	Photovoltaic energy
t	-	Time (hours)
dt	-	Service capacity
P_{PV}	-	PV power

I_{rr}	-	Solar irradiance
kW/h	-	Kilowatt per hour
kw/m^2	-	Kilowatt per meter square
G_{STC}	-	Irradiance
η_c	-	Charging efficiency
x_1	-	Number of photovoltaic modules
η_s	-	PV system efficiency
kWh/m^2	-	Kilowatt hour per meter square
E_{pv}	-	PV system energy
V_{batt}	-	Battery voltage
C_{batt}	-	Battery capacity
η_d	-	Discharging process efficiency
x_2	-	Battery number
SOC	-	State of charge
CRF	-	Capital recovery factor
r	-	Interest rate
y	-	Lifetime in years
$Cost_{PV}$	-	PV module cost
$Cost_{batt}$	-	Battery cost
c_1	-	PV module cost in MYR
c_2	-	Battery cost in MYR
CRF_{PV}	-	Capital recovery factor for PV module
CRF_{batt}	-	Capital recovery factor for battery
w_1	-	PV module weight
w_2	-	Battery weight
KG_0	-	Initial vertical distance of centre of gravity
KG_{max}	-	Maximum kilogram
h_1	-	Vertical distance of PV module
h_2	-	Vertical distance of battery
G_O	-	Initial gravity centre
kn	-	knots

wh/m^2	-	watts per square metre
MPPT	-	Maximum Power Point Tracking
Mosfet	-	Metal-oxide semiconductor field-effect transistor
$C_{L/D}$	-	Coefficient of life or drag
F_L	-	Passenger lift force
p	-	Sea water density
V	-	Boat velocity
A	-	Full or midship cross-sectional area
S	-	Platform area / frontal area

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CHAPTER 1

INTRODUCTION

1.1 Background

Schmitt, K (2010) stated that Integrated Power System (IPS) is characterized by a propulsion element that is electrically propelled and related to the onboard support systems and armament for use on patrol boats. Electric generators, transmission lines, power electronics, storage and filter elements, weapons and radar, and drive elements, such as sophisticated induction motors or permanent magnetic motors, are the primary components of the general IPS. In an integrated power system, renewable energy sources, such as solar and wind, are linked to a traditional backup system. The finest integrated combination of renewable energy systems is a stand-alone wind system with a solar photovoltaic system, which is suited for the majority of applications and takes into account seasonal fluctuations. In this final year project, the IPS is mostly fueled by solar energy since wind energy is not as steady as solar energy and solar photovoltaic systems are simpler to install on a patrol boat at sea.

Cennet özlem (2015) issued that considering the environmental effect of fossil fuels, solar energy, which is one of the renewable energy sources, is a suitable alternative to energy derived from fossil fuels. Utilizing solar energy efficiently helps to alleviate environmental and economic issues. In the past several decades, energy consumption has become a major problem due to the tremendous growth in energy demand. Moreover, environmental concerns associated with traditional energy sources, such as climate change and global warming, continue to compel citizens to seek alternative energy sources.

Cennet özlem (2015) showed that according to estimates issued by the World Health Organization (WHO) in 2011, the direct and indirect consequences of climate change are responsible for the deaths of 160,000 people year, and the rate is projected to quadruple by 2020. Natural calamities such as floods, droughts, and dramatic variations in atmospheric temperature are caused by climate change. Marine solar vehicles are boats that are driven by solar energy directly. These vehicles employ solar cells to convert solar energy into electricity, which is then temporarily stored in accumulator batteries before being used to move the boat through an electric engine and drive system. Power levels range from a few hundred to a few thousand watts. Solar power began to be used in boats in 1985, and the first commercially available solar-powered boats were presented in 1995.

Solar energy, which consists of the sun's radiant light and heat, has been harnessed by mankind by utilizing an array of ever-evolving technology since antiquity that claimed by Cennet özlem (2015). The International Energy Agency said in 2011 that the development of inexpensive, limitless, and clean solar energy technologies will have enormous long-term advantages. It will boost sustainability, decrease pollution, minimize the cost of addressing climate change, and keep fossil fuel prices lower than they would be otherwise.

This research will present how to design a solar-powered patrol boat that is propelled with inboard jet propulsion that is partly powered by photovoltaic (PV) panels. Norazlan Bin (2009) discovered that the solar electric boat is propelled by an electric motor driven by photovoltaic (PV) panels and solar energy. The solar panels were erected and fitted without affecting the boat's ability to provide a comfortable ride. This is a cost-effective means of recreation or travel across relatively small distances. The system employs a solar panel, a converter, a rechargeable battery, and an electric motor in its design of a solar-powered electric boat. Electricity consumption for the electric motor of a solar-powered boat may be minimized and made cheaper.

1.2 Problem Statement

Fossil fuel, which is civilization's major source of energy for transit, made quicker, more efficient transportation feasible without the need for human-powered machinery. Current land, air, and marine transportation systems heavily rely on fossil fuels due to their reliable capacity to provide the required energy as long as there is sufficient fuel supply for the length of the journey. Later, it was revealed that the Earth's fossil fuel reserves would not be able to meet the growing need for energy. The quantity of coal and crude oil produced from the Earth is diminishing. To improve this solution, people seek alternate and renewable energy sources to prevent the continuing depletion of oil reserves and reduce pollution as a benefit of having a clean or non-polluted and renewable energy source.

The solar electric boat is one of the alternative energies with the potential to resolve this issue. Substituting a solar electric motor for a gasoline engine might be useful for small-scale applications, particularly on boats that are exposed to direct sunlight during navigation. This thesis proposes using a solar-powered patrol boat to replace the use of petroleum. The solar electric patrol boat cannot be utilized at night, on cloudy days, or when it is raining since there is not enough sunshine to generate power. However, this issue may be resolved by using rechargeable batteries to power the solar boat's electric engine. Therefore, the preference for an electric engine for the solar electric boat must be precise and suitable. To choose an appropriate electric motor, it is important to consider the kind of motor (AC or DC) and the motor's horsepower to propel the solar-powered electric boat.

1.3 Research Objective

The primary objective of this project is to build and create a solar-powered patrol boat that is propelled with inboard jet propulsion that is partly powered by photovoltaic (PV) panels. Specifically, the objectives are listed below in detail:

a) To create a solar-powered electric patrol boat via computer simulation software by parts that utilizes the least amount of electricity for its electric engine.

b) To determine the efficiency between the solar panel conversation energy in order to construct a hybrid solar-powered patrol boat.

1.4 Scope of Research

The scope of this research are as follows:

1. As a patrol boat, the correct design, such as a semi-displacement hull, must be employed to provide outstanding performance and adequate speed, and a SolidWorks computer simulation model must be developed.

2. Use the appropriate main details for this project. For this study, student will select maximum velocity of 40 knots, overall length of 13 meters, waterline length of 10.8 metres, moulded beam of 4.1 metres, design draught of 0.7 metres. Waterjet will be made by aluminium, A34-5 waterjet series power range of 180 to 560 kilowatts, maximum displacement per waterjet unit suggested for fitting speedboats for the A34-5 series of 5 to 9 tonnes as parameters.

3. Use the actual design and improve the boat's efficiency to make it more seaworthy and safer. This solar-powered vessel is planned for patrol usage. For this study, student will select a 13-meter patrol boat with a seating capacity of seven passengers and one seat for patrol boat captain.