DESIGN AND FABRICATION OF ALTERNATIVE POWER SUPPLY FOR MARINE VESSEL USING WIND ENERGY

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DESIGN AND FABRICATION OF ALTERNATIVE POWER SUPPLY FOR MARINE VESSELS USING WIND ENERGY

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requirements for the award of the degree of
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This thesis is dedicated to

My beloved parents, Mr Kannan s/o Doraisamy and Mrs Angalamah d/o Gundan

and

my beloved wife, Karti d/o Kunasekaran

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ABSTRACT

Total power failure is one of the most crucial incident because it will result the particular ship to lose her capability to move or communicate with ships/land bases around. Total power failure usually only occurs when the generator or alternator of the ship fails to operate. Although ships been occupied with batteries for emergency purpose, but batteries can only be used until the electricity charge in it depletes by time according to its usage. This project presents an effective method to overcome total power failure by designing a hybrid system to generate power supply to the ship using wind energy. This thesis presents a design and fabrication of an alternative power supply for marine vessels using wind energy. The alternative power supply is only focused on ship emergency lighting system onboard Royal Malaysian Navy ship, KD KASTURI. The study, design and fabrication of the system covers wind turbine design, battery charging and control, power conversion and power supply to the designated equipment. This system is designed in such way that the alternative power supply from the battery charged using wind energy will be used to power up ship emergency lighting system for 2 hours during total power failure. Lantern type wind turbine coupled with a Permanent Magnet Synchronous Generator (PMSG) was designed and used in this project to generate electricity for battery charging. The charging of the battery is controlled using a MPPT charger controller. This project analyse on the charging voltage, charging current and the maximum time limit that the system can supply to the system during total power failure. As a conclusion from the obtained results, it shows that this is a reliable standalone system that able to supply power for ship emergency lighting during emergency period.

ABSTRAK

Bekalan kuasa terputus sepenuhnya adalah satu insiden penting kerana akan mengakibatkan kapal kehilangan keupayaan untuk bergerak atau berkomunikasi dengan kapal atau pangkalan lain. Bekalan kuasa terputus sepenuhnya biasanya hanya berlaku apabila penjana atau alternator kapal gagal berfungsi. Walaupun kapal telah dilengkapi dengan bateri untuk tujuan kecemasan, bateri hanya boleh digunakan sehingga caj elektrik di dalamnya berkurang mengikut waktu sesuai dengan penggunaannya. Projek ini membentangkan kaedah yang berkesan untuk mengatasi bekalan kuasa terputus sepenuhnya dengan merancang sistem hibrid untuk menjana bekalan kuasa kepada kapal dengan menggunakan tenaga angin. Thesis ini membentangkan reka bentuk dan pembuatan bekalan kuasa alternatif untuk kapal dengan meggunakan tenaga angin. Bekalan kuasa alterntif ini hanya tertumpu pada sistem lampu kecemasan kapal iaitu di kapal Tentera Laut Diraja Malaysia, KD KASTURI. Kajian, reka bentuk dan fabrikasi sistem ini meliputi reka bentuk turbin angin, pengecasan dan kawalan bateri, penukaran kuasa dan bekalan kuasa ke peralatan yang ditetapkan. Sistem ini direka bentuk sedemikian rupa supaya bekalan kuasa alternatif dari bateri caj menggunakan tenaga angin untuk menyalakan sistem pencahayaan kecemasan selama 2 jam semasa bekalan kuasa terputus sepenuhnya. Jenis turbin angin ditambah dengan penjana segerak magnet tetap (PMSG) direka dan digunakan dalam projek ini untuk menjana tenaga elektrik mengecas bateri. Pengecasan bateri dikawal dengan menggunakan pengawal pengecas MPPT. Projek ini menganalisis pengecasan voltan, pengecasan arus dan had masa maksimum yang sistem boleh bekalkan semasa bekalan kuasa terputus sepenuhnya. Kesimpulannya, keputusan dan hasil yang diperolehi menunjukkan bahawa sistem ini dipercayai

dapat membekalkan kuasa untuk pencahayaan kecemasan kapal semasa tempoh kecemasan.

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LIST OF ABBREVIATIONS

VAWT	-	Vertical Axis Wind Turbine
HAWT	-	Horizontal Axis Wind Turbine
LDP	-	Lighting Distribution Panel
PMSG	-	Permanent Magnet Synchronous Generator
KD	-	Kapal Diraja
P	-	Power
I	-	Current
V	-	Voltage
AC	-	Alternating Current
DC	-	Direct Current
R	-	Radius
H	-	Height

LIST OF SYMBOLS

ג	-	Tip Speed Ratio
ϱ	-	Aspect Ratio
p_r	-	permitivity
C_p	-	Power Coefficient
U	-	Mean Wind Speed

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Electricity is one of the most important energy needed in the ship. This is because with the vast development in the maritime industry, it already came to an extend that a ship won't be able to move without electricity supply. The importance of electricity in the ship is not only to light up the ships and provide supply for the navigation equipment, but it also plays a vital role in providing the initial spark in order to generate mechanical energy in order for the ship to move. Furthermore, when it comes to battleships, electricity becomes even more important since all the weapon systems were constructed using electrical and electronic components. Therefore, in order to accommodate the electricity consumption, a ship should be equipped with several electricity generators with several sources.

Nowadays, the interest among the scientist and technologist on the alternative energy research is increasing day to day. This is because of the decreasing amount of non-energy resources such as oil and gas which leads to price hike in global market. Most of the research is being done throughout the world is in the renewable energy sources such as solar, wind, hydro and many more. This is because these resources

are existing resources and produced continuously by the nature. Other than that, renewable energy also is clean and free from any pollution or side effects to the neither human beings nor living natures in the world. Profitable during development and direct benefit-cost impact to the user also makes it more attractive for it to be developed.

Wind energy is one of the energy which is classified as one of the renewable energy which is free from any pollution and side effects. Wind includes an important amount of energy that can be converted into useful energy, usually in mechanical or electrical energy using wind turbines [1]. Wind energy was not so popular in few countries previously due to its initial requirement that the wind in the particular area should be at least 7 m/s. However, with the improvement in wind technology which is improved small wind turbine technology and the diverse application to which it can be put to both 'grid-tied' and 'stand-alone' system, many tycoons has turned to invest in wind based researches.

In marine industry, electricity generation using wind energy as a secondary option is still not being applied since many researchers are focusing in industrial sectors. Since places with higher altitudes or near to sea is identified as the place that have higher tendency to have wind more than 2 knots, ships equipped with wind generators will have a better solutions to upkeep their electricity demand if their generators and battery chargers fails to operate.

1.2 Problem Statement

Total power failure in ships/boat is one of the most crucial incident which we would try to avoid as much as we can. Perhaps total power failure can lead the ship/boat to be taken charge by the wind and current as well can lead the ship crew to a trauma. Besides that when a ship/boat lost from any communication with

its headquarters, special team as well as ships to search and rescue the particular ship/boat.

Total power failure only occurs when the generator or the alternator fail to operate accordingly. Some ships equipped with batteries for backup in ship/boat but we have to know that batteries operation which is direct current (DC) will reduces by times when the electric charges in the battery been used until the battery dies. The battery on board ships/boats which been used to recharge the battery will only operates if the generator and alternator works because it is running in Alternating Current (AC). Once the electricity supply from the Uninterruptable Power Supply decreases and finishes after certain period of time the ship won't be having any alternative power supply source until the respective ship generator begin to operate as per normal. Therefore placement of a standalone electricity source with chargeable capability needed in the ship in order to support its electricity demand until the ship reaches nearby port or shipyard safely to conduct repair to the generators.

1.3 Objectives of Study

The main objective of the project is to design effective method to overcome total power failure by designing a hybrid system to generate power supply to the ship using wind energy. While provides a necessary background information on wind energy development using a suitable wind rotors, the specific objective of this study includes:-

1) To design an efficient wind turbine which capable harvest a maximum amount of wind energy.

2) To design and fabricate a wind generator onboard ship to be used as secondary power supply source.

1.4 Scopes of Study

The scopes of the project is set in order to achieve the target of this project. It is to make sure development of the project is heading to the correct direction as well as full filled its objectives. There are several scopes to be followed.

1) Focus only on power supply generation for ship's lighting system.

2) System designed based on height and calculated power supply consuption in Royal Malaysia Navy (RMN) ship which is KD KASTURI.

3) System able to support ship lighting system for 2 hours.

1.5 Major Contribution of Study

The major contribution for this project is to design an optimum system that can be used as emergency supply during total power failure by using wind energy onboard marine vessels. Therefore, it is expected that marine vessels especially ships and high speed craft will have a backup supply as an emergency supply during total power failure. Apart from that this system also can be used in household as an emergency supply during power failure.

1.6 Thesis Outline

This thesis is organized into five chapters. The organizations of the chapters are as follows:

Chapter 1 describes the background of the study which includes the problem statements, objectives, scopes and major contributions of this study. Meanwhile, Chapter 2 investigates the suitable wind turbine that can be fitted on board to yield the maximum wind energy at low/high wind speed. In this chapter, the suitable wind generator also been investigate to suit the turbine as well able to produce charging voltage at lower wind speed.

Chapter 3 presents the methodology and process that have been taken in order to design the suitable wind turbine with the measured wind speed at the sea in Malacca Straits. In this chapter also the suitable design and characteristic for the charger controller, battery charger, battery and inverter also been discussed and finalised. This chapter also discuss about the interconnections that have to be made in order for the system to work accordingly without any damage.

Chapter 4 presents the about results obtained from the system test on board ship. The minimum and maximum value for charging voltage and current also been discussed in this chapter. Apart from that the performance of the system on board ship including its efficiency and costing of the project been discussed.

Lastly, in Chapter 5, conclusion of the study and several recommendations for future work are stated.

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