WIND CHARGER FOR LOW WIND SPEED

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SUPERVISOR DECLARATION

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STUDENT DECLARATION

"I hereby declare that the work in this thesis is my own except for summaries and quotations which have been duly acknowledged"

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Special Dedication To My Beloved Parents, Supervisor, Lecturers, Friends And Members Who Contribute Into This Project.

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ABSTRACT

This thesis presents the developement of a wind charger for low speed wind. Wind is the one of the source of electricity distributed generation technology. Nowadays around entire worldwide can produce power by Alternating Current (AC) generator that is a common practice thus the implementation of wind charger. Wind charger is a technology which converting wind energy to electric power. Wind energy is easily accessible anywhere in the world and is one of renewable energy. However, the lower average wind speed become one of the factors wind turbine has not been used widely as alternative method for generating the electric power. Thereby, small scale wind turbine which can generate electric power in low wind speed must be develope. The advantages to use wind generator is environmental friendly refers than portable generator. As practically, wind generator does not use any raw material. But, portable generator uses the fuel or petrol to generate the electricity. On the other hand, by using wind generator we will cut cost during running the system. In this study, there are four different wind charger rotor designs which can operate at low wind speed developed and its performances are assesed by using ANSYS Workbench CFX software. Theoretical calculation have been done to obtain the power output generated and the rotational speed produced by the wind charger rotor.. The performance of the all designs are compared to choose the best and optimized design. Based on the results obtained from the simulation, Design 1, Design 2 and Design 4 are able to rotate at low wind speed condition while Design 3 is not a suitable design for this condition. The comparison between the results proved that the most efficient design is Design 2 since it has higher power output and rotational speed compared to the other designs.

ABSTRAK

Tesis ini membentangkan kaedah rekaan pengecas angin berkelajuan rendah. Angin adalah salah satu punca elektrik teknologi generasi masa kini. Pengecas angin adalah teknologi yang menukarkan tenaga angin kepada tenaga elektrik. Tenaga angin mudah diakses di mana-mana di dunia dan merupakan salah satu tenaga yang boleh diperbaharui. Walau bagaimanapun, purata kelajuan angin yang lebih rendah menjadi salah satu faktor turbin angin tidak digunakan secara meluas sebagai kaedah alternatif untuk menjana kuasa elektrik. Dengan itu, turbin angin berskala kecil yang boleh menjana kuasa elektrik dalam kelajuan angin rendah perlu dicipta. Kelebihan menggunakan penjana angin mesra alam merujuk daripada penjana mudah alih. Seperti yang dikatakan, penjana angin tidak menggunakan apa-apa bahan mentah. Tetapi, generator mudah alih menggunakan bahan api atau petrol untuk menjana elektrik. Sebaliknya, dengan menggunakan penjana kuasa angin akan mengurangkan kos dalam sistem. Dalam kajian ini, beberapa turbin angin yang boleh beroperasi pada kelajuan angin rendah dicipta dan akan dianalisis kecekepannya dengan menggunakan perisian ANSYS CFX. Pengiraan teori juga dilakukan untuk membandingkan output kuasa yang diperoleh daripada simulasi Ansys CFX. Perbandingan tahap kecekapan dibuat untuk memilih reka bentuk yang terbaik dan sesuai untuk beroperasi pada kelajuan angin yang rendah. Berdasarkan keputusan yang diperolehi daripada simulasi , Rekaan 1 , Rekaan 2 dan Rekaan 4 dapat berputar pada keadaan kelajuan angin rendah manakala Rekaan 3 adalah tidak sesuai untuk keadaan ini. Perbandingan antara keputusan membuktikan bahawa reka bentuk yang paling berkesan adalah rekaan 2 kerana ia mempunyai output kuasa dan kelajuan putaran yang lebih tinggi berbanding dengan reka bentuk yang lain.

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SYMBOL	PARAMETER
p	Power Output (W)
ρ	Density of Air (kg/m^3)
ω	Angular Velocity (rad/s)
N	Rotational Speed (rev/min)
V	Air Velocity (m/s)
A	Swept Area (m^2)
r	Radius of rotation (m)

CHAPTER I

INTRODUCTION

1.1 BACKGROUND STUDY

Wind power is the conversion of wind energy into an useful form of energy, such as using wind turbines to produce electrical power, windmills for mechanical power, windpumps for water pumping and drainage. Human kind has employed the wind, for both commerce and recreation, since antiquity. The inception of the wind turbine precedes recorded history. The reason of using wind power as the energy source is because wind is a clean fuel source which does not causing environmental pollutions. The main goal of this study is to replace the fossil fuels with renewable energy source that will not effect the environment. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land.The effects on the environment are generally less problematic than those from other power sources like gas turbine and steam turbine. There are now over two hundred thousand wind turbines operating , with a total nameplate load capacity of 282,482 MW at the end of year 2012. World wind generation more than quadrupled between year 2000 untill 2006, which is doubling every three years. China has been rapidly expanding its wind turbine installation in the late 2000 passed the United States in 2010 to become the world leader.There have been two main configurations for wind turbine which is horizontal and vertical axis wind turbine.

1.2 STATEMENT OF THE PROBLEMS

Nowadays, most of the developing countries starts using wind turbine as their backup source to produce electricity. In India, most of the rural village did not get the electricity supply due to the lack of power production source in the country. In order to overcome this dispute, the government of India starts installing wind turbine to produce more electricity so that they can solve the electricity issues. The wind turbines were installed at the high wind speed area such as sea side, hills and mountain areas. This wind turbines can only produce electricty when the wind speed is high enough to rotate the blades. Most of the turbines operates at the minimum speed of 10 m/s to 15 m/s. In this situation, wind with low speed are wasted because it was unabled to operate the turbines. There are a lot of areas in many countries where the wind energy is wasted due to the low speed reason. In Malaysia, the average wind speed distribution in the country is between the range of 1.9 m/s to 2.9 m/s. This means major places in Malaysia receives low wind speed. The wind energy in this country is wasted due to insufficient technology which can help to harness the low wind energy to produce electrical power.

1.3 PROPOSED RESEARCH

Upon further analysis, this thesis will examine the performance of slow speed wind turbine design to determine the optimum power and energy production for the given wind condition. As a continuation of prior research regarding to the performance of the slow speed wind turbine, this study will be conducted on a full-scale level where the turbine need to be designed and simulated. Data will be acquaired by simulating the design of slow speed wind turbine with varying wind speed.

1.4 OBJECTIVES OF THE PROJECT

The ultimate goal of this project is to develope an efficient wind charger rotor design which can rotate in low wind speed condition to produce power. The performance of the design is analysed using CFD simulation software to obtain the value of power output and rotational speed.

1.5 SCOPE OF PROJECT

i. This study was delimited to design, simulation and analysis of the wind charger which is aimed for improving the production of electrical power by using low speed wind.

ii. There will be four different design of wind charger developed in this study. Its either Vertical Axis Wind Charger or Horizontal Axis Wind Charger. The choice of selecting the type of wind charger is depends on the suitable design of the wind charger which can produce electrical power through low speed wind.

iii. The study involved designing a wind charger for low speed wind using CAD/SolidWorks software and analyze the performance of the designed wind charger ANSYS WorkBench CFX software. The comparison between the designs will be discussed later.

1.6 IMPORTANCE OF THE PROJECT

This project is very important to the generation of electrical power in the future. The source of fossil-fuels keep reducing from day to day. It is important to ultilize the use of renewable energy so that the usage of natural fuels can be replaced with renewable energy in the power production process. Eventough the use of wind energy keep increasing, the wind energy is still not fully ultilized. The existing wind turbines needs high speed wind to produce elctricity. This project is a new era to the wind turbine design where a wind charger that only need slow speed wind to produce electricity will be designed. This project will help to fully ultilize the usage of wind energy in the future.

1.7 DEFINITION OF TERMS

For clearer understanding of the terms used in this study, below are their meanings where the terms are organized into three sections which is (1) Electricity Transmission Network, (2) Wind Turbine Components and (3) Wind Energy Challenges, Issues and Solutions.

1.7.1 Electricity Transmission Network

Alternating Current (AC)	-	An electrical current that reverses direction at regular intervals or cycles
Direct Current (DC)	-	A type of electrical current that flows only in one direction through a circuit. Usually, relatively at low voltage and high current.

1.7.2 Wind Turbine Components

Capacity factor	-	The average power output of a wind development divided by its maximum power capability, its rated capacity. Capacity factor depends on the quality of the wind at the turbine.
Cut-in Speed	-	The wind speed at which the turbine blades begin to rotate and produce electricity.
Cut-out Speed	-	The wind speed at which the turbine automatically stops the blades from turning and rotates out of the wind to avoid damage to the turbine.
Rated Wind Speed	-	The wind speed at which the turbine is producing power at its rated capacity. The rated wind speed generally corresponds to the point at which the turbine can perform most efficiently. Because of the variability of the wind, the amount of energy a wind turbine actually produces is lower than its rated capacity over a period of time.

1.8 SUMMARY

This chapter elaborates the purpose of this study where it explains the problem statements for this research and the importance of the research. In this chapter, the objectives of this study and the scope of research area was explained briefly for a clearer understanding. While for the second chapter which the literaure review, it is all about the summary and comparison from the previous research. In this chapter, it compares the type of wind turbine and the component used which is related to the performance of the wind turbine. This chapter review about the broad area of this study and the focus area of this study. Finally, for the third chapter which is the methodology part, it explains the materials, equipment and also related calculation that needed for the designing and fabricating the prototype wind charger.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter includes all the paper works and related research as well as the studies regards to this project. The chapter contains all important studies which have been done previously by other research work. The related works have been referred carefully since some of the knowledge and suggestions from the previous work can be implemented for this project. Literature review was an on going process throughout the whole process of the project. It is very essential to refer to the variety of sources in order to gain more knowledge and skills to complete this project. These sources include reference books, thesis, journals and also the materials obtained from internet.

2.2 TYPES OF WIND TURBINES

Nowadays, there are two categories of wind turbines which is horizontal axis wind turbine and vertical axis wind turbine. Those whose rotors spin about a horizontal axis is classified as horizontal axis wind turbine while those whose rotors spins about a vertical axis is classified as vertical axis wind turbine.

2.2.1 Vertical Axis Wind Turbine (VAWT)

Vertical axis wind turbine (VAWT) is first appeared in the history of wind turbine. VAWT are a type of wind turbine where the main rotor shaft was set vertically and the main components are located at the base of the turbine. Vertical-axis wind turbines can be devided into two major groups: those that use aerodynamic drag to extract power from the wind and those that use lift for the same purpose.These machine relied upon momentum transfer or drag to produce mechanical work. In order for a moment to be created about the axis of rotation it was necessary to shield part of the rotor assembly from the wind. In this turbine, the generator and gearbox are located close to the ground, facilitating service and repair.

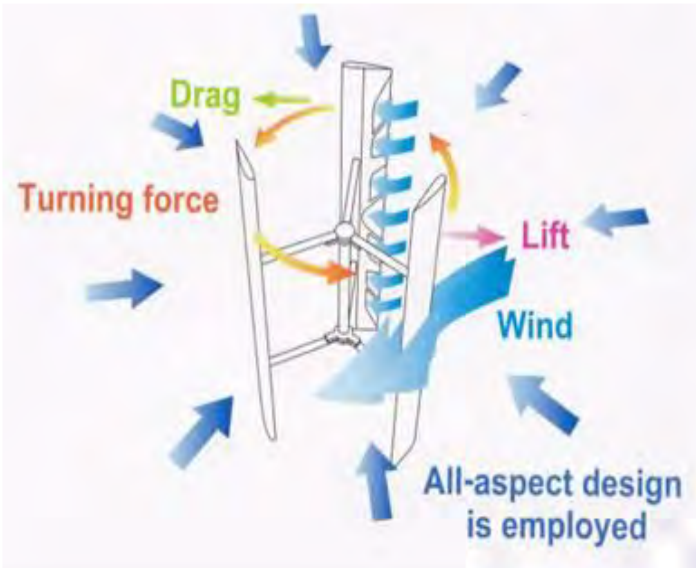

Figure 2.1 : Working Mechanism of VAWT
(Source : www.bayatenergy.co.uk)

Based on Figure 2.1, a VAWT tipped sideways, with the axis perpendicular to the wind streamlines, functions similarly. A more general term that includes this option is "transverse axis wind turbine". The dominant advantage to a VAWT is that it can accept wind from any direction at any time. This means that it does not require any yaw system to align the turbine in the direction of the incident wind field.An VAWT can be packed closer together in wind farms which allowing to free more spaces.

VAWT are omni-directional where the rotor allowed to move in any direction, it also produce lower force on the support structure.

2.2.2 Horizontal Axis Wind Turbine (HAWT)

Horizontal-axis wind turbine (HAWT) are convectional wind turbines and unlikely the VAWT are not omnidirectional. As the wind changes direction, HAWT need to change the direction with it. An HAWT should have some means for orienting the rotor with respect to the wind. HAWT have the main rotor shaft and electrical generator at the top of a tower, and must be pointed into the wind. In a HAWT, the generator converts directly the wind which is extracted by the rotor. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor.

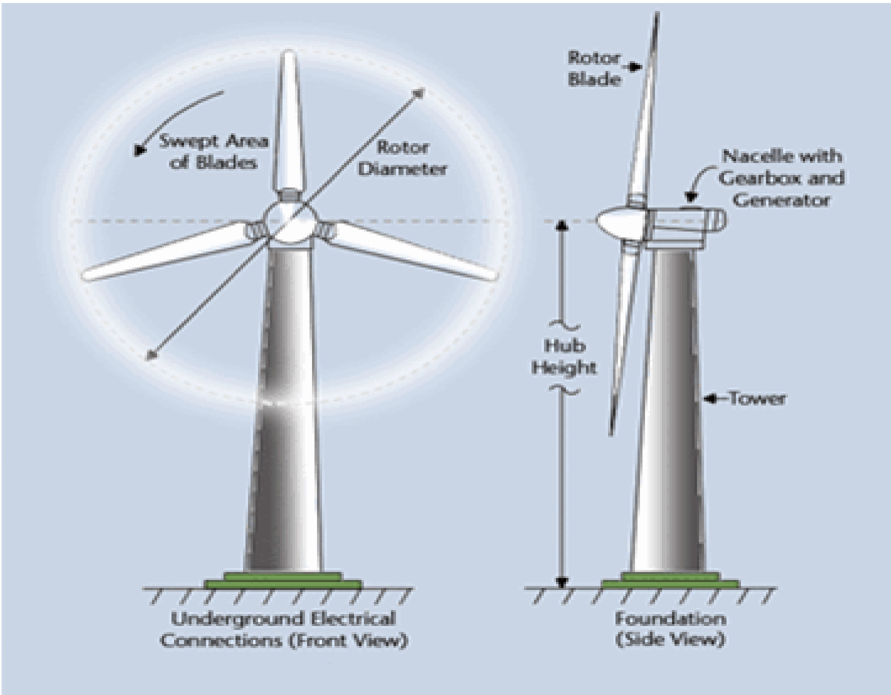

Figure 2.2 ; Horizontal axis wind turbine

(Source : www.bayatenergy.co.uk)

Figure 2.2 shows the example of horizontal axis wind turbine. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator. HAWT uses lift forces to rotate their blades