TO DESIGN A CAM-OPERATE VERTICAL WINDMILL FOR ELECTRIC POWER GENERATION

MOHD HEZERULNIZAM BIN HARUN

Laporan ini diserahkan kepada Falkulti Kejuruteraan Mekanikal sebagai memenuhi sebahagian daripada syarat penganugerahan Ijazah Sarjana Muda Kejurueraan Mekanikal (Rekabentuk dan Inovasi)

Fakulti Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka

Mei 2007

Pengesahan penyelia

"Saya akui bahawa saya telah membaca karya ini dan pada pandangan saya karya ini adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Rekabentuk dan Inovasi)"

Tandatangan : ....

Nama Penyelia : Ir. ABDUL TALIB DIN

Tarikh : 08/05/2007

IR. ABDUL TALIB BIN DIN
Deputy Dean (Research & Postgraduate Studies)
Faculty of Mechanical Engineering,
Technical University of Malaysia, Melaka,
Ayer Keroh, 75450 Hang Tuah Jaya,
Melaka.
Tel: 06-2332430 H/P: 013-2532874
Fax: 06-2332429

Pengakuan

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya"

Tandatangan :..

Nama Penuh : MOHD HEZERULNIZAM HARUN

Tarikh : 08/05/2007

ACKNOWLEDGEMENT

In the name of Allah, the most Gracious and most Merciful,

Thanks to Allah, for giving permission to complete this draft of thesis. I would like to acknowledge and express my gratitude to all these people:

- Prof. Dr. Md. Razali Bin Ayob (Dekan, Fakulti Kejuruteraan Mekanikal)

- Ir. Abdul Talib Bin Din
- (Penyelia Projek Sarjana Muda,Fakulti Kejuruteraan Mekanikal) for all his a lot of supports and advices

- All the Lecturers and Technicians in Fakulti Kejuruteraan Mekanikal. That give any kind of helps while realize this project

- And also to my family and all fellow friends, for their concern, encouragement and understanding.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOL

SYMBOL	DEFINATION
v	Velocity
K	Kelvin
A	Area
V	Volume
l	Length
c_p	Power Coefficient.
c_g	Generator Efficiency.
ω	Angular Velocity
τ	Torque
ρ	Density
N	Newton

LIST OF ABBREVIATIONS

VAWT	Vertical Axis Wind Turbine
HAVT	Horizontal Axis Wind Turbine
CAD	Computer - Aid – Drawing
TSR	Tip Speed Ratio
rpm	Revolution per Second
S.I	Standard International

ABSTRACT

A wind turbine is a machine for converting the kinetic energy in wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is then converted to electric power, the machine is called a wind generator. When designing a wind power system, it is crucial to understand the electricity load and the available resources. The only vertical axis turbine which has ever been manufactured commercially at any volume is the Darrieus machine, named after the French engineer Georges Darrieus who patented the design in 1931. (It was manufactured by the U.S. company FloWind which went bankrupt in 1997). The Darrieus machine is characterized by its C-shaped rotor blades which make it look a bit like an eggbeater. It is normally built with two or three blades. The purpose of this thesis is to design a Cam-operate Vertical Windmill. This thesis consist on the study of existing windmill/wind turbine, wind condition and project development.

ABSTRAK

Kincir angin merupakan sebuah mesin yang menukarkan tenaga kinetik daripada angin kepada tenaga mekanikal. Jika tenaga mekanikal digunakan secara terus untuk mesin, seperti mesin mencanai batu atau digunakan untuk mengepam di panggil kincir angin. Manakala jika tenaga mekanikal ditukarkan ke tenaga elektrik, ia di panggil janakuasa angin. Apabila mereka cipta sistem kuasa angin, adalah penting untuk memahami beban kuasa elektrik, kerektor angin dan sebagainya untuk rujukan dan kajian. Satu-satunya janakuasa angin menegak yang pernah dibina dan dimajukan secara komersial adalah mesin Darrieus, dinamakan bersempena nama jurutera Perancis Georges Darrieus yang mempetentkan rekaciptanya pada tahun 1931. ianya kemudian dikilangkan dan dijual oleh sebuah syarikat Amerika Syarikat iaitu Syarikat FloWind yang mana kemudiannya diistiharkan muflis pada tahun1997. Mesin Darrieus bercirikan bilah rotor berbentuk C yang kelihatan seolah-oleh seperti pemukul telur. Tujuan utama kajian ini adalah untuk merekacipta janakuasa angin berpaksi menegak dengan menggunakan aci sesondol untuk menjana kuasa elektrik.kajian ini turut menjalankan kajian terhadap janakuasa elektrik yang sedia ada dari pelbagai jenis,megkaji ciri-ciri angin dan perjalanan/pembangunan projek.

CHAPTER 1

OVERVIEW

1.0 INTRODUCTION

The wind has been used as an energy sources for thousands of years, all across the world. Very early wind machines were vertical axis structures and have been identified in China, India, Afghanistan and the Middle East, especially Persia; going back to about 250 B.C. most of the earliest machines were used for pumping water in irrigation projects.

A wind turbine is a machine for converting the kinetic energy in wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is then converted to electric power, the machine is called a wind generator.

Wind units can be divided into two major types, horizontal axis and vertical axis machines. Horizontal machines some times known as HAWT (Horizontal Axis Wind Turbines) are the traditional conventional design; they consist of a rotor with one to twenty blades driving a generator or a pump either directly or through a gearbox, chain or belt system. A tail vane or fantail is required to direct the machine into the wind. They are usually more efficient than vertical axis units known as VAWT (Vertical Axis Wind Turbines). Savonius and Darius are two designs of vertical axis machines. This type of unit is often not situated on a tower and does not have to be directed into the wind. Materials and construction are usually cheaper than horizontal axis machines.

1.1 PROJECT SCOPE

This project consists to develop a Design of cam-operated Vertical Windmill for electrical power generation. These projects need to perform the best way to generate large electricity for human requirement. Other than that, this project report covers the design of the vertical windmill. The design do must archive the objective for this project. Literature review and other research by inventor before use as a guide line to develop this project. Beside that, the study of the windmill must know the characteristic of wind in order, the site selection for the windmill setup and other considerations.

1.2 OBJECTIVE

On this design it have an objective to make sure it achieve its goal in order from solving some major problem in a real life situation. Some objective that being list below are:

1) To design a cam-follower system that used to generate electricity by using vertical axis wind turbine type.
2) To design a vertical axis wind turbine that suitable to produce a large torque and maximize the electric produced.
3) To study and understand the wind characteristic.
4) To study and understand the Vertical Axis Wind Turbine functional, system, mechanically and etc.

1.3 PROBLEM STATEMENT

The problems occur is when:

1) To determine the design of the Vertical windmill. The design must be able to produce more torque to get able to generate large electricity.
2) The site selection must be figure out before it can be install at that site.
3) The wind condition at the site must be study properly before it can be set up and install at the selection site.
4) The dimension of the Vertical windmill. It importance to determine the right dimension to get more power from wind and produce the large electricity.
5) The cams design and material selection. The experiment result needed to get the profile for the cam before it can use.

1.4 THESIS OUTLINE

In this part will summarize all the chapters contain in this first draft.

Chapter 1:
This chapter contains the introduction, problem statement, objective, and scope of project. It summarizes the basic information about the project which will be performed and the objective of this project.

Chapter 2:
This chapter concludes all the research that has been done to provide ideas and specification as a guideline to produce the design. Beside that it also covered the study of the wind condition that can influence the performance of the project development.

Chapter 3:
This chapter summarizes the design methodology and flow processes that have been planned for this project. Beside that, the criteria selection for the best concepts idea also determined.

Chapter 4:
This chapter will review about the process development of the final concept of vertical windmill. The detail drawing briefly explains in this chapter. This chapter also consists of the result and analysis.

Chapter 5:
This chapter will conclude the overall chapter in this thesis. it a conclusion about the thesis, discussion and recommended for the future design for improvement.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

In this chapter it explains about the wind turbine from its beginning until today. Generally, wind turbine is an alternative energy that used wind to generate electricity. Wind-power is the world's fastest-growing energy source, with installations increasing by about 30% a year. It is renewable, it does not pollute while in operation, it entails no future liabilities associated with decommission of obsolete plants, it lends itself to dual land use with agriculture, natural habitats, or human residence, and, perhaps most important, it is ideally suitable to produce hydrogen as a substitute fuel. It is a fact that due to economics-of-scale reasons cost effectiveness of wind-turbines increases with size.

During the last 25 years the size of the state-of-the-art wind machine has been increasing systematically but the actual technology of horizontal-axis wind turbines would ultimately reach its limits. Very large sizes would create a number of gigantism problems in rotor design, and the low rotational speed associated with large radii would complicate the coupling with the electrical generator.

2.1 DEFINATION OF WINDMILL/WIND TURBINE

A wind turbine is a machine for converting the kinetic energy in wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is then converted to electric power, the machine is called a wind generator.

There are two type of windmill/wind turbine that commonly use worldwide; the Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT). The different between the two types of wind turbine is the rotation of the blade but the mechanical concept is still remaining the same. Other type of windmill/wind turbine is offshore and onshore wind turbine. This type of wind turbine is still in development and research before it can widely use worldwide.

Horizontal Axis Wind Turbine (HAWT) is the type that largely use worldwide. This is because it can produce and generated more electricity. The reason why the HAWT is widely use is because it simple. All grid-connected commercial wind turbines today are built with a propeller-type rotor on a horizontal axis (i.e. a horizontal main shaft).

Figure 1.1: The Horizontal Axis Wind Turbine

The Vertical Axis Wind Turbine (VAWT) was popular during the early development of windmill. However, its inefficiency of operation led to the development of the numerous horizontal axis designs. For the vertical axis windmill there are two type that is commonly used; the drag based VAWT type (Savonius) and lift based VAWT type (Darrius).

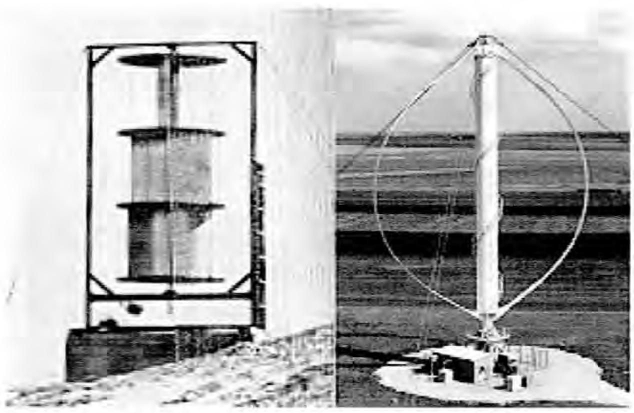

Figure1.2: Savonius Windmill on the left and Darrius Windmill on the right side

Offshore wind turbines are considered to be less obtrusive than turbines on land, as their apparent size and noise can be mitigated by distance. Because water has less surface roughness than land, the average wind speed is usually higher over open water. This allows offshore turbines to use shorter towers, making them less visible.

Figure1.3: Offshore Wind Turbine in Denmark

Onshore turbine installations tend to be on ridgelines. This is done to exploit the so-called topographic acceleration. The hill or ridge causes the wind to accelerate as it is forced over it. The addition wind speeds gained in this way make large differences to the amount of energy that produced. Great attention must be paid to the exact positions of the turbines (a process known as micro-sitting) because a difference of 30 m can sometimes mean a doubling in output.

Figure1.4: Onshore Wind Turbine placed in Washington

2.2 INTRODUCTION OF WIND ENERGY

Energy from wind is derived largely from solar radiation. Motion of the air mass in the atmosphere is caused by solar isolation and is reproduced as jet streams. These affect the ground speed (but not necessary the air speed) of high flying jet aero planes. The disturbance of atmospheric air is reproduced at ground level as wind.

Like solar energy, the wind energy is free, environmentally clean and is infinitely renewable. There are no pollution and no direct use of fossil fuels in the energy gathering process. Unlike solar energy, the wind availability is not cyclic and diurnal but intermittent, unpredictable and its not limited to daylight hours.

Wind energy is clean and safe it does not produce greenhouse gases in the same way as fossil-fuelled generating plants do. Wind energy has little or liabilities related to decommissioning of obsolete plants, unlike nuclear power. The environmental impact of wind energy has been investigated thoroughly in both Europe and the USA. Particular areas of concern that have been researched include noise emissions; the sun's reflection from the blades; and the threat to birds. Opinion surveys indicate that the majority of citizens in most European countries favor renewable energy sources such as wind power. Opinion surveys in areas of Denmark and UK with wind farms indicate that 70 to 80 % of the population is “supportive" or "unconcerned" with respect to the turbines.

Wind energy is transmitted by what is essentially a low density fluid. The physical dimensions of any device used to convert its kinetic energy into a usable form are necessarily large in relation to the power produced.

2.2.1 BACKGROUND AND HISTORY OF WINDMILL

Windmill has been used for many centuries for pumping water and milling grain. The discovery of the internal combustion engine and the development of electrical caused many windmills to disappear in the early part of this century. However, in recent years there has been a revival of interest in wind energy and attempts are underway all over the word to introduce cost-effective wind energy conversion systems for this renewable and environmentally begin energy source. In developing countries, wind power can play a useful role for water supply and irrigation (wind pump) and electrical generation (wind generators).

Man has used wind to power machines for centuries. The earliest use was most likely as a power source for sail boats, propelling them across the water. The exact date that people constructed windmills specifically for doing work is unknown, but the first recorded windmill design originated in Persia around A.D. 500-900. This machine was originally used for pumping water then it was adapted for grinding grain. It had vertical sails made from bundles of lightweight wood attached to a vertical shaft by horizontal struts. The design, known as the panemone, is one of the least efficient windmill structures invented. It should be noted that windmills may have been used in China over 2,000 years ago making it the actual birthplace for vertical-axis windmills. However, the earliest recorded use found by archeologists in China is A.D. 1219.

Vertical axis wind turbine firstly is patent for the particular design concept that being studied here was filed in France by military engineer Geoge Jean Marie Darrieus in1925. His idea received little attention and in the late 1960s the design was independently re-invented by Canadian researchers (South and Rangi, back to 1973) at the National Research Council in Otowa. Upon discovering the existing patent, they named the desugn after the original inventor. Following the 1973 Arab oil embargo, the Canadian shared their information with the technology (Sandia National Laboratories, 1987). Promising results from a number of test turbines led to two companies (VAWTPOWER and FloWind) to commence manufacture in the 1980s in California and by the mid 80s, some 500 Vertical Axis Wind Turbines (VAWTs) were generating electricity in that state.

Figure1.5: Darrius Wind Turbine that invent by George Jean Marie Darriues

Horizontal axis wind machine were too developed by the Arab nation and their use became widespread throughout the Islamic world. The concept of the windmill spread to Europe after the Crusades. The earliest European designs, documented in A.D. 1270, had horizontal axes instead of vertical ones. The reason for this discrepancy is unknown, but it is likely a result of two factors. First, the European windmills may have been patterned after water wheels that had a horizontal axis. The water wheel had been known in Europe for long before this. Second, the horizontal axis design was more efficient and worked better. In general, these mills had four blades mounted on a central post. They had a cog and ring gear that translated the horizontal motion of the central shaft into vertical motion for the grindstone or wheel which would then be used for pumping water or grinding grain. During the pre-industrial world, windmills were the electric motors of Europe. In addition to water pumping and grain grinding, they were used for powering saw mills and processing spices, dyes, and tobacco. However, the development of steam power during the nineteenth century, and the uncertain nature of windmill power resulted in a steady decline of the use of large windmill structures.

The first use of a large windmill to generate electricity was a system built in Cleveland, Ohio, in 1888 by Charles F. Brush. The Brush machine was a post mill with a multiple-bladed "picket-fence" rotor 17 meters in diameter, featuring a large tail hinged to turn the rotor out of the wind. It was the first windmill to incorporate a step-up gearbox (with a ratio of 50:1) in order to turn a direct current generator at its required operational speed (in this case, 500 RPM.) Despite its relative success in operating for 20 years, the Brush windmill demonstrated the limitations of the low-speed, high-solidity rotor for electricity production applications. The 12 kilowatts produced by its 17-meter rotor pales beside the 70-100 kilowatts produced by a comparably-sized, modern, lift-type rotor.