

FINAL YEAR PROJECT 2
ENERGY CONVERSION FROM DC GENERATOR PART IN WIND TURBINE TO
PRODUCE ELECTRICITY

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Bachelor of Manufacturing Engineering

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SUPERVISOR'S DECLARATION

We hereby declare that we had checked this work and in our opinion this project is satisfactory in terms of scope and quality for the award of the Bachelor Degree of Mechatronic Engineering.

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Specially Dedicated To My Beloved Family, Friends And Companion

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ABSTRACT

A wind turbine is a rotating machine which converts the kinetic energy of 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 instead converted to electricity, the machine is called a wind generator, or more commonly called a wind turbine. This study presents of doing an experiment of a simple wind turbine. The project is to analyze the suitable DC motor that can act as generator part in wind turbine and operate properly. Besides that, the wind turbine should generate electricity as it functions. For this process, after choosing the suitable DC generator, an experiment was undergone to determine the output voltage which is the electricity and also to check whether the DC generator operates properly. Actually the experiment was undergone using wind velocity that can be gain around us but because the wind velocity is too slow and not windy, I am using the wind velocity from fan and act as the alternative method to undergo the experiment. So to make sure that all the objectives for the Projek Sarjana Muda is achieved, the experiment and procedure must be done properly and also by referring the scope of the project.

ABSTRAK

Sebuah turbin angin adalah sebuah mesin berputar yang menukarkan tenaga kinetik angin kepada tenaga mekanikal. Jika tenaga mekanikal digunakan secara langsung oleh jentera, seperti pam atau batu pengisar, mesin biasanya dipanggil kincir angin. Jika tenaga mekanikal sebaliknya ditukar kepada elektrik, mesin dipanggil penjana angin, atau lebih dikenali sebagai turbin angin. Kajian ini membentangkan menjalankan eksperimen turbin angin mudah. Projek ini adalah untuk menganalisis motor DC yang sesuai yang boleh bertindak sebagai sebahagian penjana dalam turbin angin dan beroperasi dengan betul. Selain itu, turbin angin yang perlu berfungsi perlu menjana elektrik. Untuk proses ini, selepas memilih penjana DC yang sesuai, eksperimen telah dijalankan untuk menentukan keluaran arus voltan elektrik dan juga untuk memeriksa sama ada penjana DC beroperasi dengan betul. Sebenarnya eksperimen telah dijalankan menggunakan halaju angin yang boleh terdapat di sekeliling kita tetapi oleh kerana halaju angin yang terlalu perlahan dan tidak berangin, saya menggunakan halaju angin dari kipas angin dan bertindak sebagai kaedah alternatif untuk menjalani eksperimen. Jadi untuk memastikan bahawa semua objektif untuk Projek Sarjana Muda dicapai, eksperimen dan prosedur perlu dilakukan dengan betul dan juga dengan merujuk skop projek.

TABLE OF CONTENT

	PAGE
SUPERVISOR’S DECLARATION	ii
STUDENTDECLARATION	iii
DEDICATION	iv
ACKNOWLEDGEMENT	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENT	viii
LIST OF FIGURES	xii
LIST OF TABLES	xiii
LIST OF SYMBOLS	xiv
 CHAPTER 1 INTRODUCTION	
1.1 Project Background	1
1.2 Problem Statement	3
1.3 Objectives	3
1.4 Scope of Study	3

CHAPTER 2 LITERATURE REVIEW

2.0	Description	4
2.1	Experiment	4
2.2	Theoretical Analysis	5
2.3	Wind Turbine Research	6
2.4	Advantage Of Wind Turbine	7
2.5	Small Wind Turbine	8
2.5.1	Basic Component	9
2.5.2	Permanent DC Motor	10
2.5.3	Permanent Magnet Generator	11
2.5.4	Low-Speed Direct Drive Permanent Synchronous Generators	13
2.5.5	Emulator Construction	14
2.5.6	Variable Shaft Speed Operation	
2.6	Summary	15

CHAPTER 3 METHODOLOGY

3.1	Overall Methodology	17
3.2	Literature Review	17
3.3	Complete Wind Turbine System	18
3.4	Block Diagram	18
3.5	Flow of Development	19

3.6	Experiment Procedures	20
3.6.1	Dc Generator	21
3.6.2	Multi-Meter	22
3.6.3	Light Emitting Diode	24
3.7	Experimental Set-Up	25
3.7.1	Dc Motor (Generator)'s Testing – Without Load	26
3.7.2	Dc Motor (Generator)'s Testing – With Load	26

CHAPTER 4 RESULT AND ANALYSIS

4.1	Introduction	27
4.2	Theoretical Result	27
4.3	Experimental Result	28
4.4	Data Recorded	29
4.5	Output Voltage Vs Distance	29
4.5.1	Output Voltage With No Load Graph	30
4.5.2	Output Voltage With Load Graph	31
4.6	Discussions	32

CHAPTER 5 CONCLUSIONS AND RECOMMENDATION

5.1	Introduction	35
5.2	Conclusions	35
5.3	Recommendation	36

REFERENCES	37
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APPENDICES

A1	Final Year Project 1 Gantt Chart	40
A2	Final Year Project 2 Gantt Chart	41

LIST OF FIGURES

Figure No	Title	Page
Figure 2.1	Wind Turbine Close Up	8
Figure 2.2	Principle Of A Rotating Dc Machine	10
Figure 2.3	AC/DC/AC Power Electronic Interfaces For A Wind Generator	12
Figure 2.4	Typical Structures Of Gearbox Generator (a) And Direct-Drive Generator (b) Of A Wind Plant	12
Figure 2.5	Wind Turbine System	14
Figure 2.6	Wind Turbine Simulator System	14
Figure 3.1	Block Diagram	18
Figure 3.2	Flow Of Development	19
Figure 3.3	12V DC Generator	21
Figure 3.4	Multimeter	21
Figure 3.5	Light Emitting Diode	23
Figure 3.6	Experimental Set-Up	25
Figure 4.1	Output Voltage With No Load	30
Figure 4.2	Output Voltage With Load	31

LIST OF TABLES

Table No	Title	Page
Table 3.1	List Of Component	20
Table 4.1	Data Recorded	29

LIST OF SYMBOLS

T	=	rotor torque
B	=	magnetic flux
R	=	average winding radius
l	=	effective conductor length (stack length)
Z	=	number of conductors
i	=	current flowing in the conductor
V	=	induced voltage
$\overline{v_y}$	=	velocity of inductor perpendicular to the magnetic field
$\overline{B_x}$	=	magnetic flux vector
RPM	=	rotation per minute
ω	=	angular velocity
P	=	power

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

“Wind energy” or “wind power” describes the process which is used wind to generate mechanical power. This mechanical power can be used for specific tasks or a generator can convert this mechanical power into electricity to power homes. Wind turbines turn in the moving air and power on electric generator that supplies an electric current.

Wind turbine work is like a fan but fan using electricity to make wind, however wind turbines turns the blade which spin a shaft, then connects to generator and lastly it will makes electricity. In energy-generating windmills, the shaft is connected to an induction generator inside the structure. The wind turns the fans, which provides the kinetic energy to spin the wires in the generator

Wind power means using the wind - harnessed by either a turbine, wind mill, wind pump or even sails (for ships) - to generate the desired amount of electricity to be used for home and commercial purposes. This provides an efficient power alternative that is clean, abundant and completely environmentally friendly. This means that a natural resource is used to produce clean, environmentally friendly power.

The most common ways of harnessing the power of the wind is using sails to propel ships and sail boats across the water. The most desirable way of using the wind to generate electricity is by erecting wind turbines.

There are two categories of wind turbines: the horizontal axis design (HAWT) and the vertical axis design (VAWT). Since it is the more practical and popular, the HAWT enjoys more attention than its sibling, the VAWT.

The HAWT has its main rotor shaft at the top of the column along with the electrical generator. The turbines must be pointed into the wind and is positioned favourably by either a small weathervane or a wind sensor. The rotor shaft and gearbox of the VAWT are positioned vertically and are also installed near the ground. This makes it more accessible for maintenance and other necessary adjustments. One of the reasons why this type of wind turbine is less popular is that it can produce what is known as pulsating torque.

As the wind turns the blades of the turbine they, in turn, turn the shafts running down the tower and are connected to a generator. The working of the shafts and the friction of the turning shafts link into the generator which then converts the energy created by the wind turbine into the useful electricity that is needed.

Windmills works in 3 parts :-

- 1) Blades (the parts that look like fan) - “catch” the wind. Sitting at a slight angle to the direction of the wind, the blades are pushed in a circle as the wind blows against them.
- 2) Hub of the windmill – like the hub of a wheel, with the fans sticking out like spokes around it. Then the fans turn the hub as they move in a circle.
- 3) The part where hub is attached to the shaft, which spins as the hub spins. The shaft is connected to whatever mechanism the windmill is designed to turn such as generator part.

After finish the blade part, the next part is induction generators. Windmills that generate energy contain induction energy. It does not make energy, but rather converts kinetic (physical) energy into electrical by spinning a wire within a magnetic field, which causes an electrical current to flow through the wire.

1.2 PROBLEM STATEMENT

During the development of generator part for wind turbine, the analysis of each element need to be criticized so that the specific component used can be known. The details of type of material used also must consider in order determining the production of generator part of wind turbine experiment. Therefore, analysis must be done in order to know the strength and weakness of making the generator part in order to produce the output voltage.

1.3 OBJECTIVE

The objectives of this study are:

- To generate the DC permanent magnet motor as generator part in wind turbine.
- To gain the output power from the shaft rotation of DC permanent magnet motor.

1.4 SCOPE OF STUDY

- Literature review and study of wind turbine generator.
- Research and analysis component that use in generator part.

CHAPTER 2

LITERATURE REVIEW

2.0 DESCRIPTION

Literature review and research on theories related to the projects begin after the title of project was decided. These involve theories of numerous of wind turbine by obtaining most of the information from the internet and a few reference book. Small scale wind turbine was chosen to be developed in this project because it was relevant based on size and cost involved.

2.1 EXPERIMENT

F. Wang, L. Bai, J. Fletcher, J. Whiteford, and D. Cullen (2007) studied on a small domestic wind turbine with scoop. The aim of this study is to investigate the possibility of improving wind energy capture, under low wind speed conditions, in a built-up area, and the design of a small wind generator for domestic use in such areas. The activities reported in this paper are optimization of a scoop design and validation of the CFD model. The final design of scoop boosts the air flow speed by a factor of 1.5 times equivalent to an increase in power output of 2.2 times with the same swept area. Wind tunnel tests show that the scoop increases the output power of the wind turbine. The results also indicate that, by using a scoop, energy capture can be improved at lower wind speeds. The power generation of such a new wind turbine is expected to be increased, particularly at locations where average wind speed is lower and more turbulent.

A.K. Wright and D.H. Wood (2007) analyze that the magnitude of gyroscopic rotor shaft and blade bending moments on a free yaw wind turbine rotor are proportional to the product of rotor speed and yaw rate. An analysis is presented of the relationship between two variables and wind speed, based on field test data from a 2 m diameter wind turbine with a tail-fin furling system, and in reference to the recent revision of the International Electro technical Commission standard for small wind turbine design. Examples are given of fast yaw rates caused by furling, and by large wind direction changes at relatively small wind and rotor speeds. Analyses of data showed that reducing turbine yaw moment of inertia increases the magnitude of maximum yaw rate for a given rotor speed, and that yaw rate is highly influenced by tail fin aerodynamics.

2.2 THEORETICAL ANALYSIS

S. Roy (1997) studied on optimal planning of wind energy conversion systems over an energy scenario. The wind power system design must optimize the annual energy capture at a given site. The only operating mode for extracting the maximum energy is to vary the turbine speed with varying wind speed such that at all times the TSR is continuously equal to that required for the maximum power coefficient. The theory and field experience indicate that the variable-speed operation yields 20 to 30% more power than with the fixed-speed operation. In the system design, this trade-off between energy increase and cost increase has to be optimized. In the past, the added costs of designing the variable pitch rotor, or the speed control with power electronics, outweighed the benefit of the increased energy capture. However, the falling prices of power electronics for speed control and the availability of high-strength fiber composites for constructing high-speed rotors have made it economical to capture more energy when the speed is high.

J.S. Rohatgi and V. Nelson (1994) present the analysis for the generation of wind power. Power regulation and control issues must be addressed in a modern HAWT. When the wind speed increases to a value at which the generator is producing rated power, some control action must occur so that the generator does not exceed its rated capacity and overheat. Typical methods of power regulation at rated wind speed are pitch regulation, stall regulation, and yaw control or furling. Pitch regulation is accomplished by providing rotating bearings at the blade root and actively changing the blade pitch angle relative to the wind, thus regulating power. Stall control is accomplished by designing the rotor so that aerodynamic stall is reached at rated wind speed and the rotor power is limited by airfoil stall. Yaw control or furling turns the entire rotor out of the wind either vertically or horizontally at rated wind speed and regulates power by reducing the rotor area exposed to the wind. The latter approach is generally only employed on small wind turbines.

2.3 WIND TURBINE RESEARCH

Wind turbine is a rotating machine which converts the HT kinetic energy T_H in HT wind T_H into HT mechanical energy. The developments of wind turbine start since 200 B.C which in Persia but until 250 A.D the usage of wind turbine had been introduced by Roman Empire. In 7th century, the first vertical axle windmills had been developing at Sistan, Afghanistan. These windmills had long vertical drive shafts with rectangle shaped blades. It was made of six to twelve sails covered in reed matting or cloth material and used to grind corn and draw up water and was used in the grist milling and sugarcane industries.

Besides that, wind turbine technologies still grown up until 1908 at United States. There have 72 wind-driven electric generators from 5 kW to 25 kW. The largest machines were on 24 m (79 ft) towers with four-bladed 23 m (75 ft) diameter rotors. Around the time of World War I, American windmill makers were producing 100,000 farm windmills each year, most for water-pumping.

However in 1954, the first utility grid-connected wind turbine operated was built by the John Brown Company at Orkney Islands, United Kingdom. It had an 18 meters diameter, three-bladed rotor and a rated output of 100 kW. From 1955 until nowadays, every country want to used these technologies as alternative and renewal energy. More developments and research have been done to use wind turbine as renewal energy because have more advantages for natural. There have 3 level of range for the wind turbine. They are large scale for 500 kW until 5 MW, medium scale between 10 kW until 500 kW and the small scale is below than 10 kW.

2.4 ADVANTAGE OF WIND TURBINE

Wind for now is the renewable energy, that's why we use wind turbine energy for resource and technology of choice. The most important is it was a "free" resource and naturally. Also its a "clean" resource due to replacement of a "dirty" energy source (coal) and no emissions associated with its use. Wind turbine can be utilized on underutilized land or on lands and currently in commodity crop production. Also which is can be "harvest" on the surface and "harvest" above the surface. Then it will primarily be used for electricity generation for immediate end-use.

Wind turbine one of the best choose that we have because it was no air emissions and also don't have Greenhouse Gas Emissions. The most important is, it no need for fuel to mine, transport, or store for the source. It also don't need any equipment like cooling water that we always use at fuel engine and nuclear reactor. There are free from making pollution for example water pollution that always produces by human activity. After all there is no waste when used wind turbine.

2.5 SMALL WIND TURBINE

In this project, I need to build a prototype of inner component in the wind turbine that can converting the energy of the wind into mechanical energy. Wind power is the conversion of wind energy, such as using wind turbines to make electricity .

The vast majority of wind turbines consist of rotor blades which rotate around a horizontal hub. The hub is connected to a gearbox and generator, which are located inside the nacelle. The nacelle houses the electrical components and is mounted at the top of the tower. In a grid-tied configuration the electricity from the generator is routed to an inverter which converts the electricity from direct current (DC) to the alternating current (AC) that electrical grids use. [3]

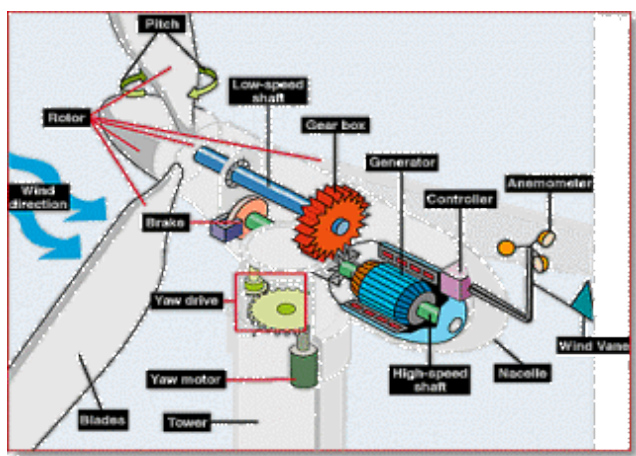
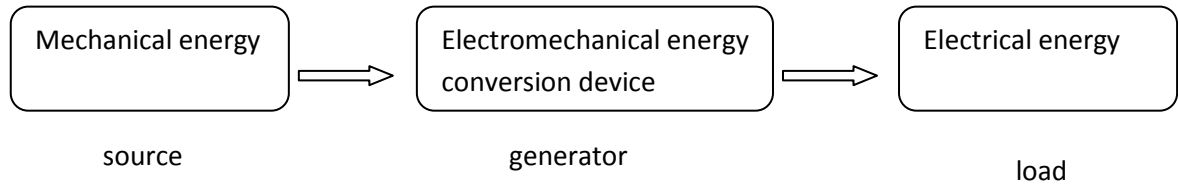


Figure 2.1 : Wind Turbine Close Up

System operation of wind turbine is when the rotor begins to rotate (spin) after the wind speed reaches, the battery charging commences at a slightly higher speed, depending on the battery state of charge. Then when the battery is fully charged, the charge controller disconnects the turbine from the battery. The turbine will produces a three phase alternating current (AC) that varies in voltage and frequency as the wind speed varies. Next ,the controller (regulator) rectifies this AC into the direct current (DC) required for battery charging and controls the energy supplied to the batteries to avoid overcharging.

2.5.1 BASIC COMPONENT



- Electromechanical energy conversion occurs when there is a change in magnetic flux linking a coil, associated with mechanical motion.
- DC motors consists of one set of coils, called armature winding, inside another set of coils or a set of permanent magnet, called the stator.
- Stator :
 - Stationary outside part of a motor.
 - Stator of a permanent magnet DC motor is composed of two or more permanent magnet pole pieces.
 - Magnetic field can alternatively be created by an electromagnet.
- Rotor :
 - Inner part which rotates
 - Compose of winding (called armature windings) which are connected to the external circuit through a mechanical commutator
 - Both stator and rotor are made of ferromagnetic materials. The two are separated by air-gap
- Winding:
 - Made up of series or parallel connection of coils
 - Armature winding : the winding through which the voltage is applied or induced
 - Field winding : the winding through which a current is passed to produce flux (for the electromagnet)
 - Windings are usually made of copper.

2.5.2 PERMANENT DC MOTOR

Electromechanical energy conversion employing generators and motors play a crucial role in energy consumption and production. Permanent magnet technology represents a new enhanced area that can be used both in generators and motors. Permanent magnet motors are well-known class of rotating and linear electric machines used in both motoring and generating modes. Permanent magnet machine describes all electromagnetic energy conversion devices in which the magnetic excitation is supplied by a permanent magnet or several permanent magnets. The energy converters using permanent magnet include a variety of configurations, and such terms as motor, generator, alternator, stepper motor, linear motor, actuator and many others to describe them.

A machine with a high torque or high power density and high efficiency at a low design operating speed can be considered for the direct-drive wind turbine application. A machine's ability to provide a significant reduction in the cost of converting wind derived mechanical power to electric power by eliminating the geared speed increaser, typically used into wind power applications. For this reason, the technology of low-speed, high-torque motors requires scrupulous evaluation in order to determine their suitability for a direct-drive wind turbine application.

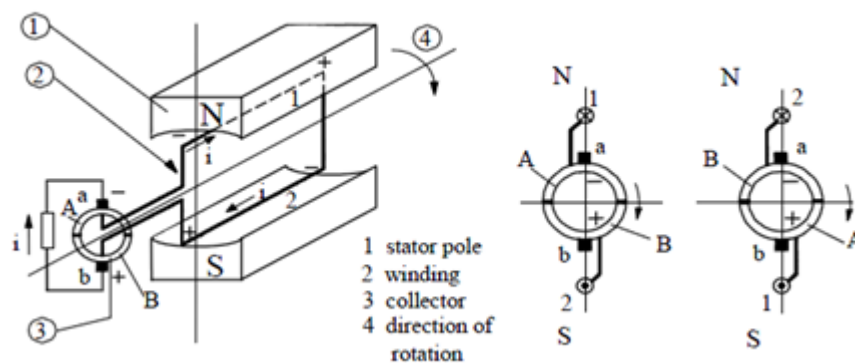


Figure 2.2 : Principle Of A Rotating DC Machine

The principle can directly be used to develop a 2-pole rotating DC machine. Motor as well generator operation can be derived from figure above. The collector or commutator guarantees the un in directionality of the current.

We can use permanent magnet motors, because they are widely available, reliable because of the nature of their construction, and start generating electricity at almost any RPM. Inside a permanent magnet motor is a coil of wound copper surrounded by permanent magnets. These type of motors rotate using electromagnetic induction, which means electricity is supplied to wound copper wire which creates a magnetic field. The magnetic field created by the electricity flowing through the copper wire opposes the permanent magnets in the motor housing. As a result, the copper wire that is attached to the shaft of the motor tries “to push” itself away from the permanent magnets. So your motor starts spinning.

2.5.3 PERMANENT MAGNET GENERATOR

Random output variation is one of the significant characteristics of wind power. With a PM generator coupled to a wind turbine, the voltage output will be varying with its rotor speed because of the wind speed variation. A permanent magnet generator has no excitation control and hence produces a voltage proportional to the shaft speed which in turn varies with the wind speed. The earliest and still most widely used power electronic circuit for this application uses an AC/DC/AC technology in which the variable frequency, variable voltage from the generator is first rectified to DC and then converted to AC and fed to the grid

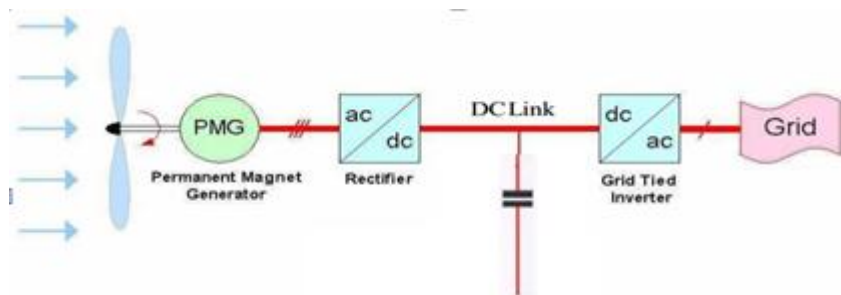


Figure 2.3 : AC/DC/ AC Power Electronic Interface For A Wind Generator

(Figure 2.3). The continuous variation of wind speed will result in a DC link voltage varying in an uncontrolled manner with a more demanding role and specification for the DC-AC inverter.

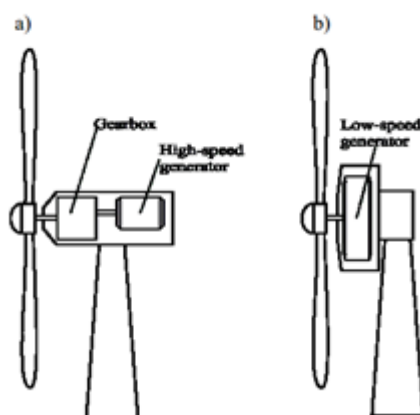


Figure 2.4 : Typical Structures Of Gearbox-Generator (a) And Direct-Drive Generator (b) Of A Wind Power Plant

Permanent-magnet (PM) synchronous generators are one of the best solutions for small-scale wind power plants. Low-speed multiple PM generators are maintenance-free and may be used in different climate conditions. The use of a gearbox causes many technological problems in a wind power plant, as it demands regular maintenance, increases the weight of the wind plant, generates noise and increases power losses. These problems may be avoided using an alternative – a direct-drive low-speed PM synchronous generator (Fig. 2.4b).

2.5.4 LOW-SPEED DIRECT-DRIVE PERMANENT MAGNET SYNCHRONOUS GENERATORS

In small-scale wind power plants very often low-speed direct-drive synchronous generators are used. Due to low rotational speed of the synchronous generator directly connected to the mechanical shaft of the wind rotor, the generator has a multiple construction. A synchronous generator may be excited by traditional current-carrying field winding or by permanent magnet system of high energy. Synchronous generators with permanent magnet excitation for small-scale wind power units are more maintenance-free and reliable in long-term exploitation. The generators were of a conventional construction of a typical synchronous generator with radial magnetic flux in the air gap between the inner rotor and the outer stator.[2] Alternator are designed to charge (storage) batteries (accumulators). Then, the alternator converts the mechanical (rotational) energy of the rotor into electricity (three phase alternating current). The magnets are in the rotor, which allows suppression of the rings and brushes for connection. The number of poles will improves the alternator performance at low speed, increases the mechanical parts life and reduces the noise level. The rotor system allows the efficient conversion of wind linear movement in to alternator rotational movement.

2.5.5 EMULATOR CONSTRUCTION

The emulator is based on the energy conversion system shown in 2.5. The laboratory system is realized by replacing the gearbox, wind and turbine rotor with a PC, ac–dc converter, dc drive, and dc motor as shown in Fig. 2.6. The PC implementing MATLAB/Simulink uses a wind shear/tower shadow model, an inertia model, steady-state characteristics, and a variable wind to control the dc system to emulate the driving torque of a wind turbine. These models will be briefly outlined as well as the computer hardware components along with the drive equipments.[1]

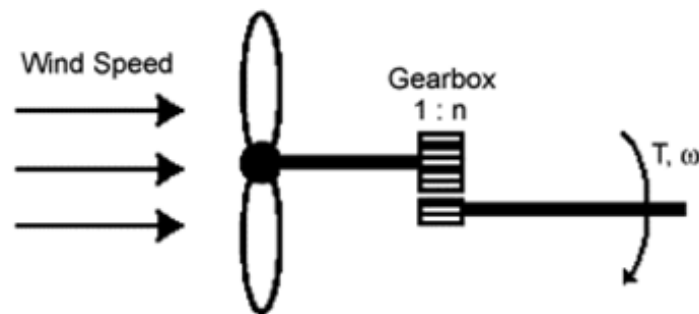


Figure 2.5 : Wind Turbine System

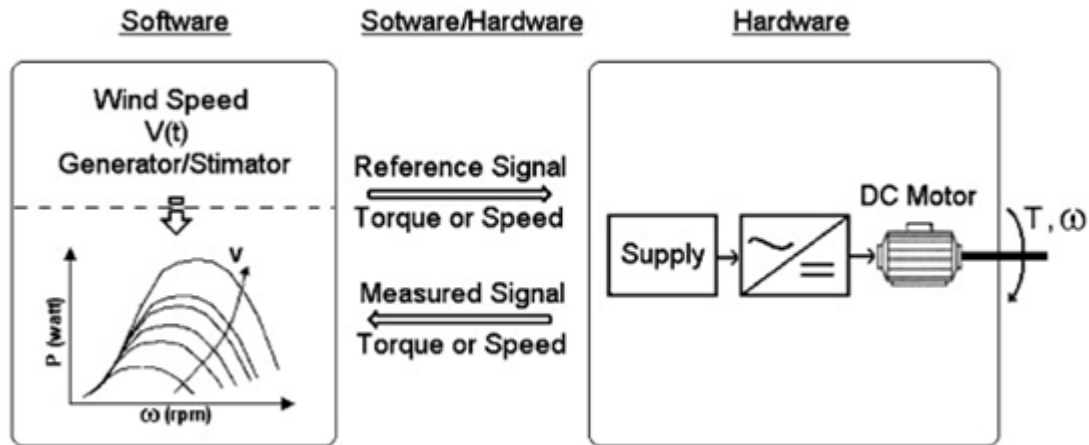


Figure 2.6 : Wind Turbine Simulator System

2.6.6 VARIABLE SHAFT SPEED OPERATION

In the wind turbine systems, the turbine is allowed to rotate at different speeds with the varying wind speed. It is usually desired to ensure optimum power transfer. The actual speed of rotation is determined by the torque versus speed characteristics of both the turbine and the generator. In the operating mode, major control means are inevitably placed on the electrical side. Obviously, the control of electrical systems is easy to implement, more reliable and less costly than the control of mechanical systems. In addition, synchronous machines may be used in variable shaft speed. In this case, operation of the system at the most efficient working condition is possible.

However, it is important that the shaft speed may vary over a wide range from cut-in wind speed to cut-out wind speed. The frequency at the output varies considerably and a non-standard generator design is required. The generated voltage may be rectified and used to supply a DC bus with battery storage back-up. When a constant voltage supply, constant frequency is required, the DC supply voltage may be used to drive an inverter which converts the energy to the desired form. If the generator is operating as a constant voltage, constant frequency source, the frequency of the stator flux and its magnitude remain constant in the operating range. It is because, the size of the machines need not be any larger than that of a commercial machine. It is even possible to operate the wound-rotor generators above their ratings in this mode of operation.

2.6 SUMMARY

In chapter 2, it is about how idea and concept in running experiment of a generator part for small scale of wind turbine based on literature review and short case study that has been figure out. The journal and technical paper stated that the wind turbine can produce electricity either in low speed wind or in high speed wind. In the next chapter 3 is about research methodology where is about the system of collecting data for research projects and the data may be collected for either theoretical or practical research. It will discuss the guideline to run an experiment of a generator part to gain the output voltage method and how the process plan being carried out to complete the project analysis.

CHAPTER 3

METHODOLOGY

3.1 OVERALL METHODOLOGY

Methodology gives the brief idea to what the method that has been adopted throughout the project. The flow of the whole project is illustrated as in figure in the following page.

In this project, I need to find the best way to show the produce of electricity from the rotation of wind turbine blade. All methodology principles and theories discussed in Chapter 2 were utilized to achieve the project's objectives.

The research methodology flowchart for this project was shown in figure. The literature review of the wind turbine was carried out to obtain basic understanding of the project.

3.2 LITERATURE REVIEW

A literature reviews on related materials is conducted by referring information available from the online and offline journals, books and the internet. All the obtained knowledge from literature review is important when it comes to conceptual product. First and foremost, some basic understanding of wind turbine model should be done by studying the development of wind turbine from the past to the current.

3.3 COMPLETE WIND TURBINE SYSTEM

When considering installing a wind turbine, it is important to realize that a complete wind turbine system consists of more than just the turbine itself. In this project, I need the turbine, for sure, but just as important is a power storage device to hold the energy, a voltage regulator to maintain the output voltage at a constant value and a USB charger circuit as to show the existence of electricity from wind turbine.

3.4 BLOCK DIAGRAM

This is the last phase of this project where the experiment of the rotation of DC motor generator is been run based on finalized detailed engineering analysis.

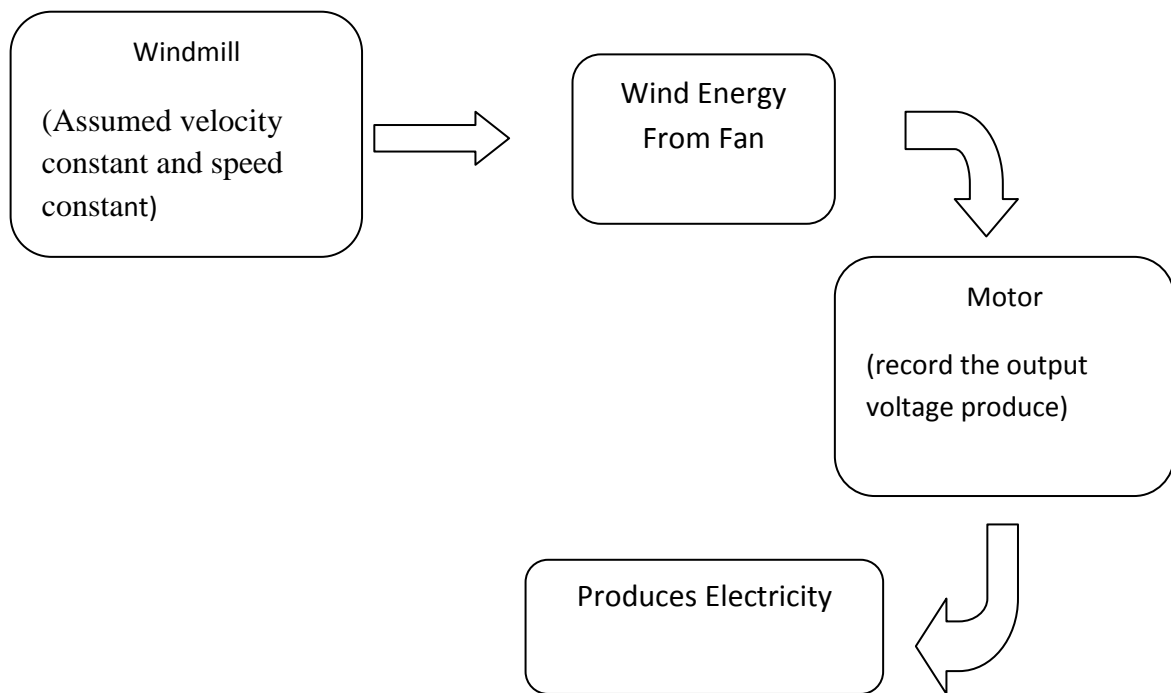


Figure 3.1 : Block Diagram

3.5 FLOW OF DEVELOPMENT

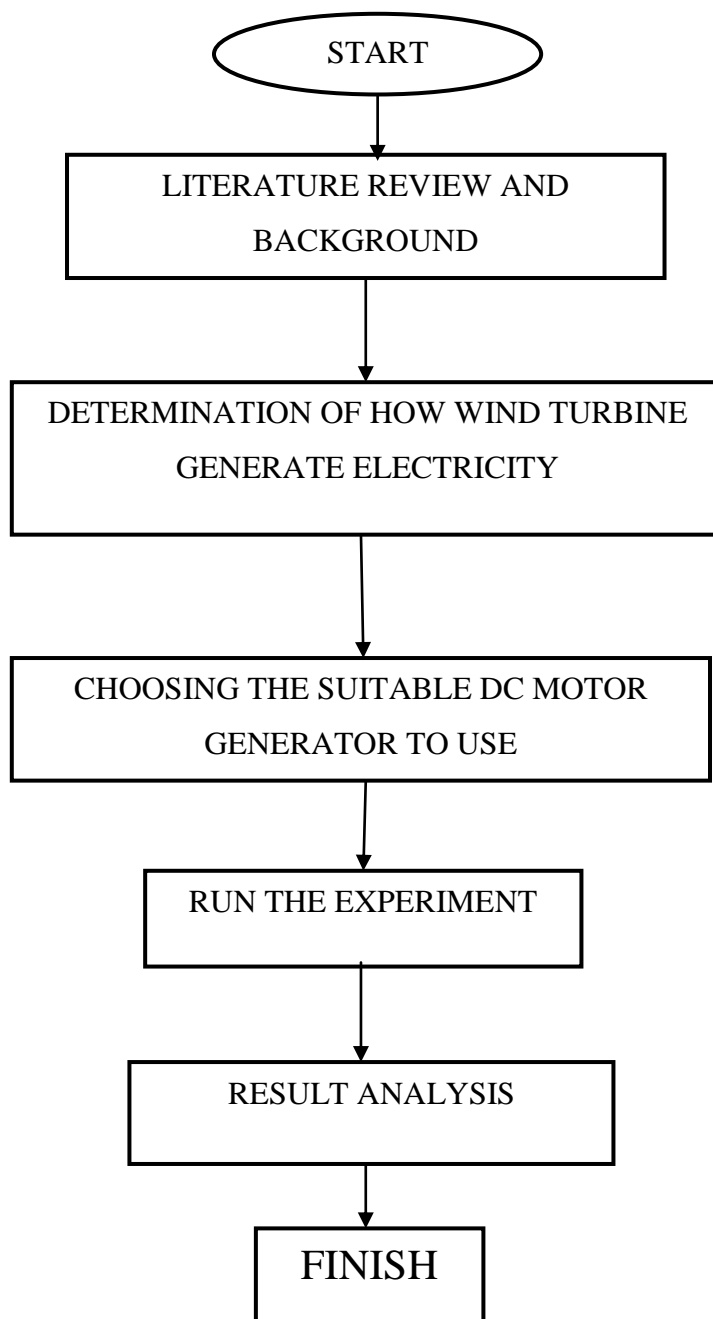


Figure 3.2

3.6 EXPERIMENTAL PROCEDURES

Experimental procedure is a step-by-step recipe for our experiment. A good procedure is so detailed and complete, so that someone else can do the experiment exactly. The first step of designing the experimental procedure involves planning of how I change my independent variable and how I will measure the impact that this change has on the dependent variable. And, all the controlled variables must remain constant. Only, then I can be sure that the change I make to the independent variable actually caused the changes of observing in the dependent variables. I need to run the experiments more than once to verify that results are consistent. In other words, I must verify that I obtain essentially the same results every time I repeat the experiment with the same value for my independent variables. This insures that the answer from the question is not just an accident. Each time that I perform the experiment is called a run or a trial. So, the experimental procedure should also specify how many trials I intend to run.

Component	Unit
12V DC permanent motor (generator)	1
LED	1
Multi-meter	1

Table 3.1 : List Of Component

3.6.1 DC GENERATOR

The most important part when build a wind turbine prototype is to find a good wind turbine motor. There is one important fact that I absolutely must understand before choosing a motor for wind turbine. The fact is when a wind turbine and the motor is attach to them, it will spin roughly 500 RPM's. The best motor for a wind turbine generator is one that produces the highest amount of voltage at the lowest possible RPM's.

Assumed that, velocity and speed is constant. So that, I am considered that an average wind generator spins at about 500RPM's. So, I choose a DC motor that have 12 Volts.



Figure 3.3 : 12V DC GENERATOR

- Benefiting from high torque and low noise, this motor is solidly constructed and ready to install in numerous applications.

Key Specifications/Special Features:

- Motor performance data
 - Motor voltage
 - Workable range: 3 to 12V
 - Nominal: 6V constant
 - At no loading
 - Speed: 16340rpm
 - Current: 0.54A
 - At maximum efficiency
 - Speed: 12340rpm
 - Current: 3.4A
 - Torque: 100g.cm
 - Output power: 12.65W
 - Efficiency: 62%
 - Stall torque: 408g.cm

3.6.2 MULTIMETER

A multimeter or a multimeter, also known as a VOM (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter would include basic features such as the ability to measure voltage, current, and resistance. Analog multimeters use a microammeter whose pointer moves over a scale calibrated for all the different measurements that can be made. Digital multimeters (DMM, DVOM) display the measured value in numerals, and may also display a bar of a length proportional to the quantity being measured.

Digital multimeters are now far more common than analogue ones, but analogue multimeters are still preferable in some cases, for example when monitoring a rapidly-varying value. A multimeter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.



Figure 3.4: Multimeter

3.6.3 LIGHT-EMITTING DIODE

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Appearing as practical electronic components in 1962, early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness. When a light-emitting diode is switched on, electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the colour of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. A LED is often small in area (less than 1 mm^2), and integrated optical components may be used to shape its radiation pattern.^[8]

LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. However, LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.



Figure 3.5 : Light-Emitting Diode

3.7 EXPERIMENTAL SET-UP

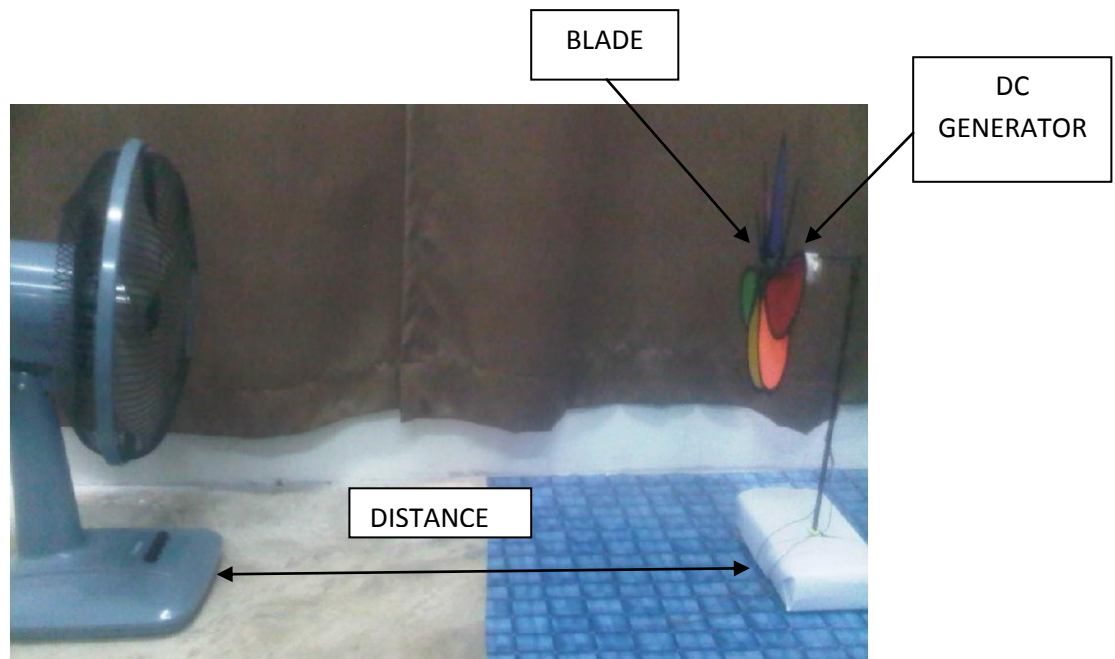


Figure 3.6 : Experimental Set-Up

Three variables that use in this experiment are :

- 1) Distance from fan
- 2) Presence of load
- 3) Voltage output produce

The distance of wind turbine from fan is adding constantly for every 15cm until 90cm. Then, the multi-meter is use to measure the output voltage that produce by the shaft rotation of DC generator. The use of LED as load is to compare the result of output voltage produce. The blade use has the diameter of 30cm.

3.7.1 DC MOTOR (GENERATOR)'S TESTING – WITHOUT LOAD

Setting the multi-meter to measure 0-20 volts. Then, connect leads from multi-meter to the terminals on the DC permanent magnet motor (generator). The multi-meter should display a voltage output when DC permanent magnet motor (generator) rotor is turned.

Note : without a load, the readings on the multi-meter may not be stable.

3.7.2 DC MOTOR (GENERATOR)'S TESTING – WITH LOAD

Load is the part of an electrical circuit that “used the electricity”. The load converts the electrical energy into another form of energy. The proper way to test the turbine is to measure voltage across a load. Use a load if the meter measurements jump around while trying to read them. The load can be anything such as LED.

Note : The LED and DC permanent magnet motor (generator) with no light up / run, but they still use some electrical energy to heat up.

CHAPTER 4

RESULT AND ANALYSIS

4.1 INTRODUCTION

This chapter discusses the results, finding and the analysis of the project. The outcome of this research will be discussed in detail by the next subtopic.

4.2 THEORETICAL RESULT

The volts-to-RPM ratio of a permanent magnet motor is defined as the volts required to spin the motor at a given RPM (rotation per minute). This number provides a rough estimate of how many volts the motor will generate at a given RPM.

The motor is 12 Volts and 16340 rpm motor.

It volts to RPM ratio is : $(12 / 16340) = 0.00073 \text{ V/RPM}$

Then I assumed that the 12 Volts and 16340 rpm motor is spinning at 500 rpm.

The calculation of how much voltage will produce at that rpm is :

$(500 \text{ rpm}) \times (0.00073 \text{ Volts/rpm}) = 0.37 \text{ volts}$

Now, there is one more step to do. I must multiply 12 Volts by 80%. It is because the 12 Volts is the number only if the motor is being used as a motor. This motor is not being used as a motor. It is being used as a generator, and it is not 100% efficient as a generator. It is roughly 80-85% efficient as a generator.

$$\text{Therefore : } 0.37\text{Volts} \times 0.80 = 0.30 \text{ Volts}$$

4.3 EXPERIMENTAL RESULT

Experimental result is obtained after doing the experiment and the result is used. In the experiment, the speed from the wind is assumed as 600 rpm. The longer distance of generator and wind source is in 90cm.

The motor is 12 Volts and 16340 rpm motor.

It volts to RPM ratio is :

$$(12 / 16340) = 0.00073 \text{ V/RPM}$$

Then I assumed that the 12 Volts and 16340 rpm motor is spinning at 600 rpm.

The calculation of how much voltage will produce at that rpm is :

$$(600 \text{ rpm}) \times (0.00073 \text{ Volts/rpm}) = 0.438 \text{ volts}$$

Now, there is one more step to do. We must multiply 12 Volts by 80%. It is because the 12 Volts is the number only if the motor is being used as a motor. This motor is not being used as a motor. It is being used as a generator, and it is not 100% efficient as a generator. It is roughly 80-85% efficient as a generator.

$$\text{Therefore : } 0.438\text{Volts} \times 0.80 = 0.35 \text{ Volts}$$

4.4 DATA RECORDED

Distance From Wind (cm)	With No Load (Volt)	With Load (Volt)
15	1.02	0.82
30	0.88	0.76
45	0.76	0.62
60	0.66	0.56
75	0.58	0.42
90	0.50	0.35

Table 4.1 : Data Recorded

4.5 OUTPUT VOLTAGE vs DISTANCE

The graph is obtained after doing the experiment. The output voltage from the rotation of rotor from the DC permanent magnet motor (generator) is taken. The output voltage is from different test which is with no load and load. The load that have been used is LED.

4.5.1 OUTPUT VOLTAGE WITH NO LOAD

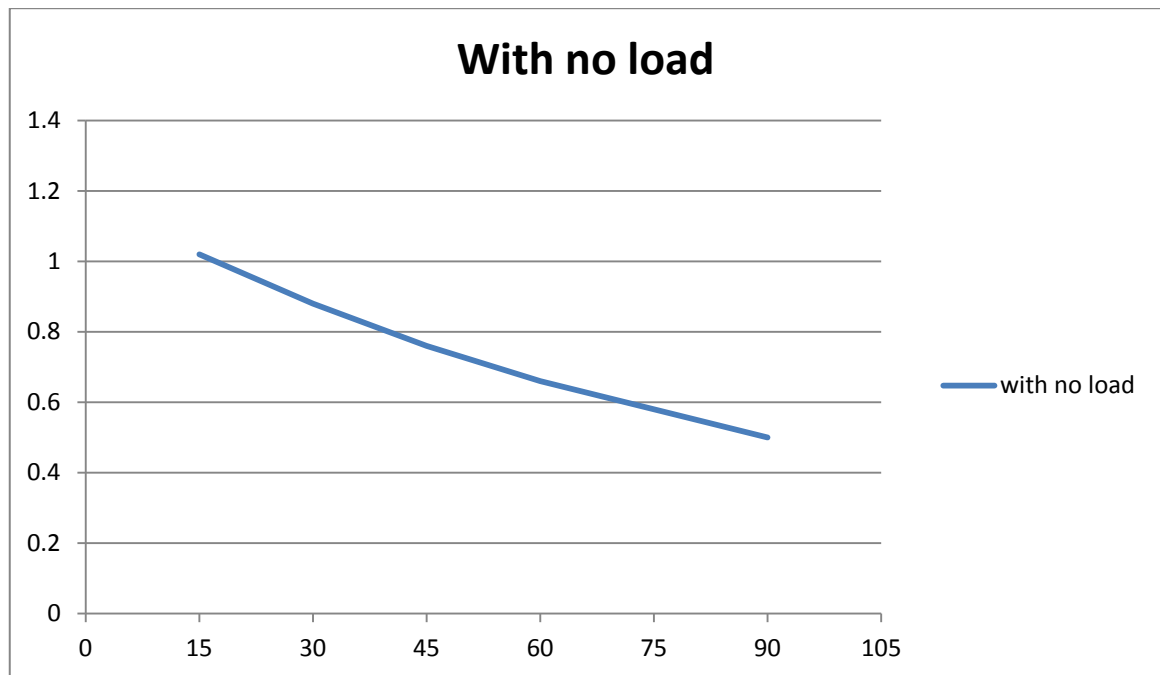


FIGURE 4.1 : Output Voltage With No Load

- ❑ The output voltage is decreasing when the distance of wind source is increasing.
- ❑ The higher output voltage is 1.02V while the lowest output voltage is 0.50V.

4.5.2 OUTPUT VOLTAGE WITH LOAD

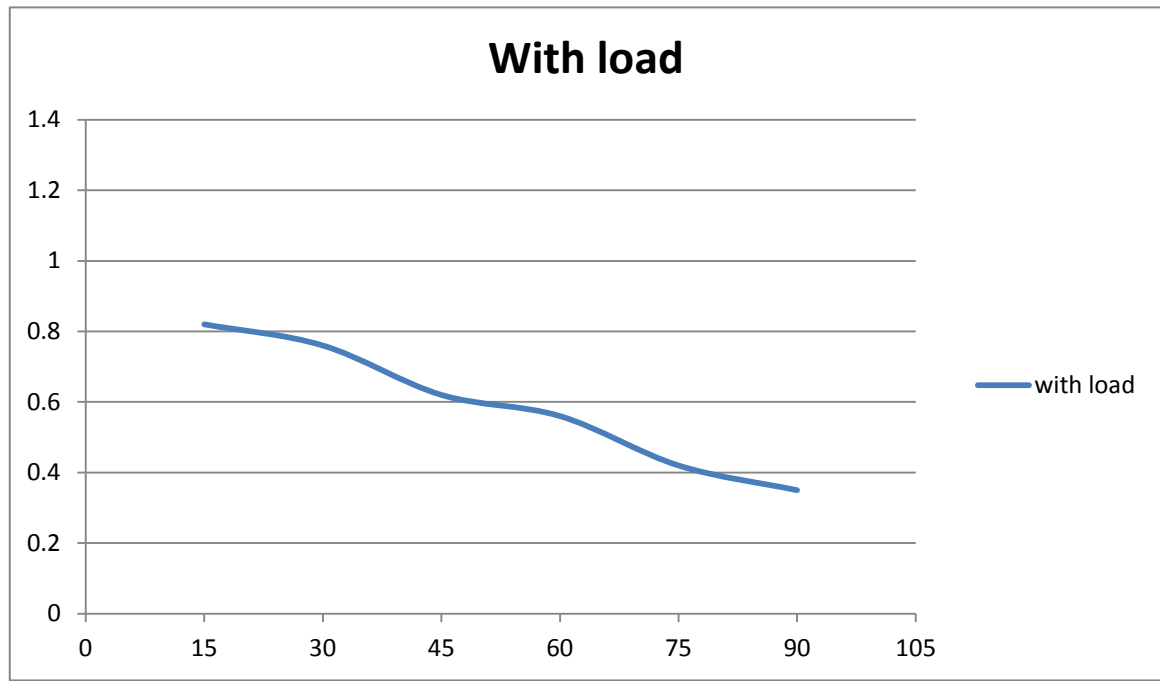


FIGURE 4.2 : Output Voltage With Load

- ❑ The output voltage is decreasing when the distance of wind source is increasing.
- ❑ The higher output voltage is 0.82V while the lowest output voltage is 0.35V.
- ❑ The output voltage become more less because of the addition of load which is LED.

4.6 DISCUSSIONS

The DC generator in the wind turbine is actually a DC motor that spins using the energy in the wind. The magnets and wires in the generator transform the energy in the wind into electricity. By manipulating the strength of the magnets used and coils of wire inside the generator we can affect the power output. In this experiment, the speed of DC permanent magnet motor (generator) is decreasing when the distance from the wind source is increasing. The rotor begins to rotate (spin) when the wind speed reaches. The turbine produces a three phase alternating current (AC) that varies in voltage and frequency as the wind speed varies.

Most generators are direct current (DC), which means that it can use as the generator. As the distance of DC generator from the wind source is increasing constantly, the speed of rotor also become decreasing. Because of that, the output voltage taken from the DC motor terminal is also decreasing. The output voltage with no load is more compare to output voltage with load. It is because the load which is the LED also used the voltage. Furthermore, the output voltage from the DC permanent motor cannot light up the LED because the yellow and green LED need about at least 1.75 volts to light, but very little amperage. Because of the higher output voltage that can be produce is only 1.02V, it does not have enough voltage to light up.

DC permanent magnet motor (generator) operate on the principle that a force is generated when current flows in an inductor that is placed in a magnetic field. Force generated in a conductor and in magnetic field.

This force generates torque in a rotary motor :

$$T = B \cdot r \cdot l \cdot Z \cdot i$$

T : rotor torque

B : magnetic flux

R : average winding radius

l : effective conductor length (stack length)

Z : number of conductors

i : current flowing in the conductor

A conductor that moves in a magnetic field generates a voltage :

$$V = \int_0^1 \overline{B} \times \overline{v} \cdot d\overline{z} = -\overline{B} \cdot \overline{v} \cdot l$$

V : induced voltage

\overline{v} : velocity of inductor perpendicular to the magnetic field

\overline{B} : magnetic flux vector

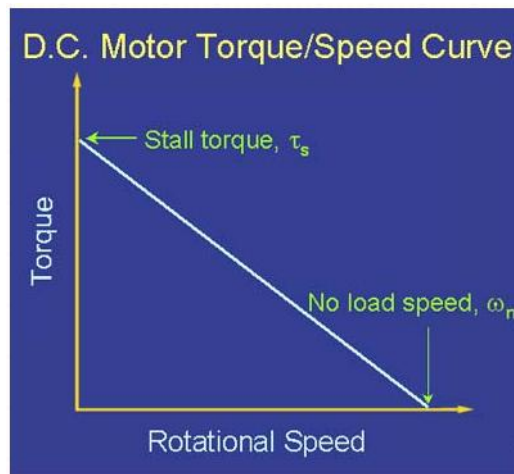


Figure 4.3 : DC Motor Torque / Speed Curve

Torque and speed are inversely proportional.

To keep the voltage constant the current will increase : $V \cdot I = \tau \cdot \omega$

Increasing current will increase torque at the expense of speed: $\tau = Kt \cdot I$

In order to increase speed, you need to increase voltage: $\omega = V/Ke$

Magnetic field strength is directly proportional to the torque constant, Kt . So as magnetic field strength is increased or decreased, the torque, τ , will increase or decrease proportionally. Which makes sense because the stronger the magnetic field, the stronger the "push" on the armature. Magnetic field strength is also directly proportional to the voltage constant, Ke . However Ke is inversely proportional to the angular velocity:

$$\omega = V/Ke$$

So, as the magnetic field increases, the speed will decrease. This again makes sense because the stronger the magnetic field, the stronger the "push" on the armature so it will resist a change in speed. Because power out is equal to torque times angular velocity, and power in equals power out (again, assuming 100% efficiency):

$$P_{in} = \tau \cdot \omega$$

So any change to torque or speed will be directly proportional to the power required to drive the motor.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter provides conclusion of finding on this project. Future development and recommendation are noted as a topic in this chapter for enhancement of knowledge in continuing this analysis and research about the generator part in wind turbine system. This topic is about the resolution of the all chapter in this project.

5.2 CONCLUSION

In Chapter 1, the problem statement has been developed and the scope of study also was developing in order to achieve the objective. The aim of this project is to show that rotation of shaft DC motor as generator part can produce output voltage.

In Chapter 2, literature review was crucial because it is necessary to get the exposure and information about the project scope and objective. At first and the most important things in conducting this project is the understanding about energy conversion from dc generator part in wind turbine to produce electricity which is the basic foundation in this project. Knowledge about generator part in wind turbine is necessary and need to understand more about this project. This information is important when analyzing stage that took place in chapter 4.

In Chapter 3, it describes method involves in calculating or choosing the criteria of the DC permanent motor (generator) in order to choose the suitable motor. By doing the experiment, the output voltage that produce by the rotation of shaft in DC generator can be recorded. The variables that use in the experiment also can be specified. Finally product evaluation stage is really important whereby this stage is the way for one to obtain data.

In Chapter 4, the main focus is present the result and finding of the project based on the theoretical analysis. In this project, the objective is to analyze and select a suitable motor for the generator part in wind turbine. The motor that was selected is DC permanent motor(generator). After doing the experiment, the output voltage that have been produced is recorded. The experiment is involved of the presence of load which is LED and without the load. Then, the result is plotted in the graph.

5.3 RECOMMENDATION

For the future development purpose, the project research and analysis must be considered the hall effect of the motor. This is because this kind of element also gives an influence in motor performance. By the way, certain aspect also must be included for the future purpose, like how much power, torque, and speed should be applied on the motor. Finally, wind turbine should recommend to enhance this further study in subject course because wind turbine are not widely use in our country. So that, our citizen can know the advantages of this wind turbine. We should appreciate and use wind energy around us because it actually can provide electricity to us.

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APPENDIX A

FINAL YEAR PROJECT 1

ACTIVITY \ WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing project title from supervisor	 													
Meeting with supervisor	 												 	
Study the objective and problem statement			 											
Literature review			 									 		
Develop flow chart and methodology								 				 	 	
Proposal submission (draft)												 	 	
Presentation and FYP proposal													 	 

Plan



Actual



FINAL YEAR PROJECT 2

ACTIVITY \ WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Meeting with supervisor														
Develop flow chart and methodology														
Planning the experiment														
Choose experiment's material														
Run the experiment														
Collecting data														
Result analysis														
Final presentation														
Thesis writing														

→ Plan
→ Actual