ELECTRICAL CONTROL FOR DOUBLE-SHAFT VERTICAL WIND TURBINE

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ELECTRICAL CONTROL FOR DOUBLE-SHAFT VERTICAL WIND TURBINE

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ABSTRACT

The availability of wind power in Indonesia has not been utilized yet. The strong wind can be used to rotate the turbine's rotor. Conventionally, vertical wind turbine type has been commercially used in many power plants because it can transform wind energy to electricity. It does not require more space and thus, it can be employed in limited area. Vertical wind turbine offers smaller area compared to the horizontal one. We used the D*C Generator*to get the motion from the turbine blades attached to its rotor shaft. Using a voltage regulator, aims to get an output of 12 volt of DC electricity. To transform the 12 volt DC to 220 volt AC, the inverter is required. In this research, we chose 1000 watt power inverter. At the end of the circuit, we use the MCB (miniature circuit breaker) to protect against overload or short circuit. We used a mechanical MCB, operate automatically to connect and disconnect the electrical circuit in the ordinary and extraordinary situation. The average of wind speed measured by anemometer is about 8 meter per second. This condition results shaft speed approximately 450 rpm and 14.4 Nm of torque. In summary, the electricity generated is about 780 watt hours AC.

Keywords: wind, turbine, vertical, generator, regulator, inverter, electricity.

INTRODUCTION

In our everyday life, electricity is the main requirement to be met. All activities often involve equipment that is powered by electricity. The fulfilments of the demand for electricity, cause many efforts to generate electricity. In general, electricity is generated by a generator driven by the turbine. As an input to generator, we used oil, coal, natural gas or other energy sources. Oil, coal, natural gas is a non renewable energy sources. The Ministry of Energy and Mineral Resources of the Republic of Indonesia stated that an increase in energy consumption by21.87% in the period 2000to 2009(Lemigas-Indonesia, 2012).The conditions inspire us to improve efforts in the use of renewable resources. Renewable resources include hydropower, wind power, geothermal, and solar energy. One of the utilization of wind power is used as the driving wind turbines. Generally, there are two types of wind turbines, vertical axis and horizontal axis. The advantage of vertical axis wind turbine is a relatively small space requirement, compared to the space for the horizontal axis one. This basic characterise a major consideration in the design of vertical axis wind turbine in a densely populated area, such as in urban areas, for example, Surabaya-Indonesia. Vertical axis wind turbines are divided into two types, namely Darrieus and Savonius.

The objective of this paper is designing a savonius wind-turbine, with double shaft, to optimize the capture of wind energy by the pairs of propeller. Wind power is expected to generate maximum rotation and torque. Mulyono *et al*, 2014 has succeeded in designing a savonius wind-turbinewith6pairs of blades (12 blades in total) were assembled on two pieces of the shaft, to capture wind power optimally. Meanwhile, the changes of wind-strength require electrical control system, in order to generate electricity as optimal as possible. Electrical control systems a redesigned aiming to generate a voltage of 220volts, so it is ready for use to operate electrical appliances.

LITERATURE REVIEW

Savonius Wind Turbine [3]. Savonius wind turbines are a type of vertical-axis wind turbine (VAWT), used for converting the force of the wind into torque on a rotating shaft. The Savonius turbine is one of the simplest turbines. The maximum power of a Savonius rotor is:

$$P_{max} = 0.36\, h\, r\, v^3 \qquad (1)$$

where h and $r$are the height and radius of the rotor, respectively, while $v$is the wind speed. The angular frequency of a rotor is

$$\omega = \frac{\lambda v}{r} \qquad (2)$$

where$\lambda$is a dimensionless factor called the tip-speed ratio. The range λ varies within is characteristic of a specific windmill, and for a Savonius rotor λ is typically around ≈ 1.

DC Generator [4]. The DC Generator is an electrical machine which converts mechanical energy in the form of motion, into electrical energy in the form of a dc voltage and current by using the principles of magnetic induction. The voltage and current output produced by a dc generator depends on its shaft speed (rpm) and the electrical load connected to it.

The shaft speed required to reach any particular output voltage is determined by the load. The lighter the load, the lower the rpm needed to reach the specified voltage. Then low rpm dc generators are a popular choice for use in wind power and hydro power battery charging systems.

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DC generators are usually used for wind turbine. The way to generate dc electricity is to spin a coil inside a magnetic field such that the magnetic lines of force generated by the magnetic field are cut by the spinning coil. Magnets have two poles, north and south, and that magnetic flux emerges from the North Pole and flows back to the South Pole.

In a DC generator we can make this magnet circuit in two ways. Firstly, feeding some of the generators output power back into its own field coils to make an electromagnet which can be precisely controlled or secondly to use permanent magnets to generate the magnetic flux rather than current in a coil of wire.

The advantage of permanent magnets is that no field supply is needed as the magnetic field is permanently excited reducing costs, and it also means that there is no I^2R power loss in the magnetic field winding, which helps to increase the generators efficiency.

WIND TURBINE ELECTRICAL CONTROL

First, we designed a savonius wind turbine attached 3 pairs of blades (Figure-1).

Figure-1. Savonius Wind Turbine.

Using the rotation resulted by the wind power, the turbine activated the generator to convert the energy become electricity. Figure-2 shows a diagram of the design of the electronic control for electricity generation using wind turbines.

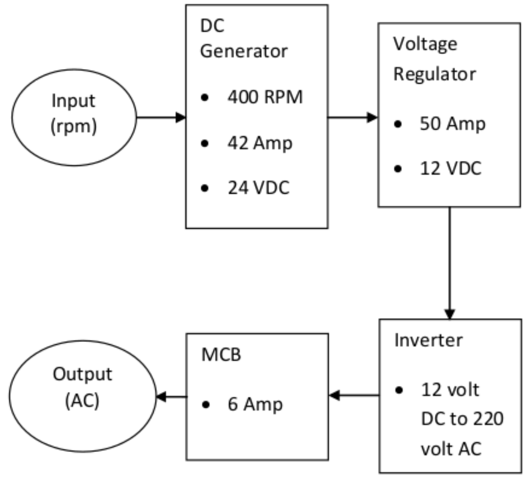

Figure-2. The diagram of electronic control for electricity generation.

We used DC generator, voltage regulator and an inverter. A MCB (miniature circuit breaker) is used at the end. It is a mechanical device, operate automatic operation designed to connect or disconnect an electrical circuit in the ordinary or extraordinary situation. The main function of the MCB is to protect the equipment (or circuit) from overload and short circuit. In a DC generator as the armature rotates a full 360° every rotation, the generated current must pass through what is called a commutator which is constructed from a copper ring split into segments with insulating material between each segments. We have selected the generator with the specification of 400rpm, 42Ampere, 24volts. This relates to the average of the rotation of the wind turbine shaft, which is450rpm. Figure-3 contains the circuit of voltage regulator and inverter.

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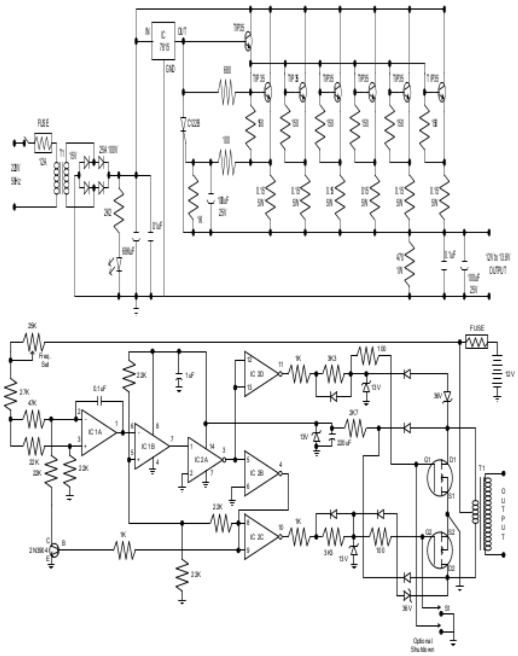

Figure-3. Voltage Regulator - Inverter.

RESULT AND DISCUSSIONS

After designing the mechanical parts of a wind turbine; and complete the electronic control part, we continue to do some experiments. Table 1 contains the results of measurements of the electrical energy generated by the wind turbine.

Table-1. The electrical energy generated by the wind turbine.

No.	**Wind speed** (km/hour)	**Shaft speed** (rpm)	**AC output** (watt hour)
1	29	450	780
2	25	428	629
3	27	446	701
4	20	392	571
5	23	416	602

The experiments were performed when the wind speedis morethan10km/h. Menet (2004) and Ross et al (2011) stated that minimum wind velocity is 10 m/s. The maximum electrical energy obtained when the wind was blowing hard (about 30 km/h), which is about780watthours.

CONCLUSIONS

The turbine has been operating well, and has been producing electrical energy.

ACKNOWLEDGEMENT

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