Design of Savonius-Darrieus a Hybrid Wind Turbine

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Design of Savonius-Darrieus a Hybrid Wind Turbine

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Abstract: *Savonius wind turbine design use type two blades with a diameter of 15.5 cm, a height of 10.9 cm and turbine weight of 51.3 g. The Darrieus wind turbine design uses type three blades with dimensions 21.8 cm x 8.7 cm x 2.3 cm. The weight of each blade is 51.3 g with the angle between the blades being 120º. The voltage of 2.5 V produced a minimum turbine rotation speed of 284.2 rpm and a maximum of 296.0 rpm. When the voltage was increased to 5.0 V, the minimum speed is 342.8 rpm and a maximum speed of 366.4 rpm. When given a voltage of 7.5 V, a minimum speed of 461.7 rpm and a maximum of 481.3 rpm were produced.*

Keywords : hybrid wind turbine, turbine rotation, design, vertical axis, savonius, darrieus

I. INTRODUCTION

The most commonly used wind turbine is the Horizontal Axis Wind Turbine (HAWT) in which the axis of rotation is parallel to the ground. However, there is another type of wind turbine, the Vertical Axis Wind Turbine (VAWT) which is the focus of this study [1, 2].

VAWT has a number of advantages over HAWT, namely simple construction, VAWT can accept wind from all directions and VAWT works well in places with relatively low wind strength and constant wind [3, 4]. VAWT has two types of turbine configurations, i.e. the drag type where the wind turbine moves due to drag force (wind drag) against the wind captured by the blade and the type of lift where the wind turbine moves due to lift force (lift force) to the wind [5]. This research aims to design an efficient Hybrid VAWT.

Wind energy is an energy that can be used to drive turbines. A wind turbine is a system that functions to convert wind kinetic energy into mechanical energy on the turbine shaft. There are two types of wind turbines, namely Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT).

Savonius and Darrieus Wind Turbines

Savonius wind turbines are VAWT which the wind direction is ignored because the turbine will still rotate for all wind directions [6, 7]. This wind turbine is ideal for use in areas with erratic wind directions. However, Savonius wind turbines only have an efficiency of around 15%. This means that only 15% of the wind energy that hits the turbine turns into mechanical turbine energy. Turbine speed cannot rotate faster than wind speed [8].

Darrieus wind turbines are VAWT can rotate faster than wind speeds up to several times [9, 10] due to Darrieus wind turbines produce smaller torque compared to Savonius wind turbines. This makes the Darrieus wind turbine more suitable to be used as an electric generator than the Savonius wind turbine.

Hybrid Wind Turbines

In the development of VAWT, Hybrid wind turbines are the latest VAWT [11]. A hybrid wind turbine is a combination of Savonius wind turbines and Darrieus wind turbines in one vertical axis. This turbine has two forces in its rotation, namely the drag force (drag force) of the Savonius wind turbine that functions as self-starting and lift force (lift force) blade of the Darrieus wind turbine which functions to accelerate the turbine rotation [12].

II. MATERIALS AND METHOD

Savonius wind turbine design uses type 2 blades with a diameter of 15.5 cm, a height of 10.9 cm and turbine weight of 51.3 g. The material used to make Savonius blade is aluminium cans, while for making Savonius plates is a canopy. Iron glue is used to glue the blade to the plate. At each plate, an L connection is installed which will be used to connect the Savonius wind turbine to the Darrieus wind turbine. L joints are made of modified aluminium cans (Fig. 1).

Fig. 1. Savonius Wind Turbine

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Design of Darrieus Wind Turbines

The Darrieus wind turbine design uses type 3 blades with each blade having a length of 21.8 cm, a width of 8.7 cm, and a height of 2.3 cm. The weight of each blade is 51.3 g where the frame was made using plywood boards, connected and coated with aluminium foil and paper. The three blades are connected using plywood boards and the angles formed between the blades are 120º. The total weight for a Darrieus wind turbine is 238.2 g (Fig. 2).

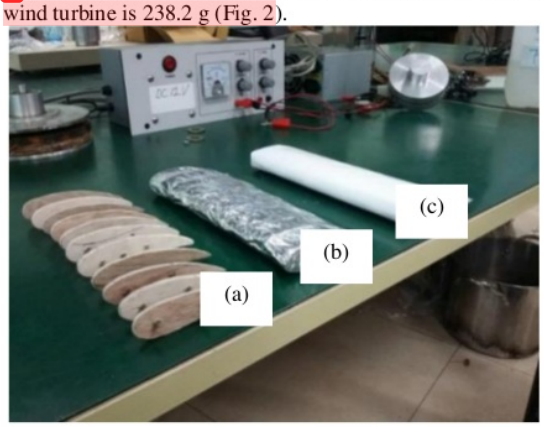

Fig. 2.Blade

(a) Initial Blade, (b) Blade after coated with aluminium foil, (c) Blade after coated with paper

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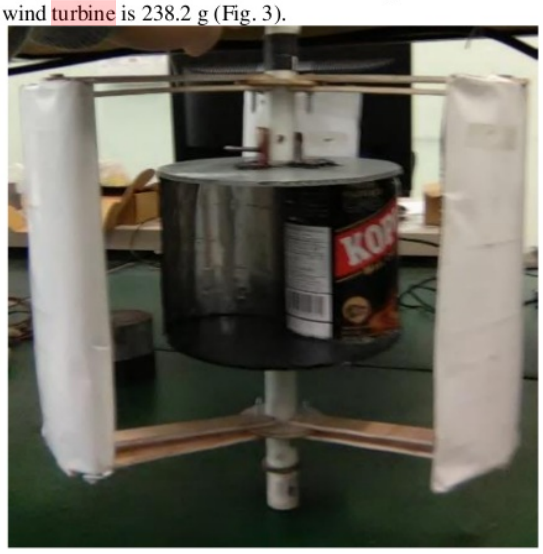

Fig. 3.Hybrid wind turbine (Savonius - Darrieus)

The hybrid wind turbine design used is a combination of two blades Savonius wind turbines and three blades Darrieus wind turbines with a diameter of 29.0 cm. a height of 32.0 cm and turbine weight of 330.7 g.

Hybrid Wind Turbine Testing Procedure

Tool testing was carried out in the following stages :

a. Install a hybrid wind turbine with a motorcycle dynamo that is connected to the power supply. Dinamo as a simulation of a hybrid motor wind turbine.
b. Install a hybrid wind turbine with a bicycle light dynamo. Dinamo acts as a hybrid wind turbine generator, installed at the top of the turbine.
c. The first test is testing the turbine rotation with an rpm meter.
d. The second test is testing the generator output voltage with a multimeter.
e. The input voltage of the power supply is varied (2.5 V; 5.0 V; 7.5 V)

III. RESULTS AND DISCUSSION

Based on the testing procedure, the results of testing the turbine speed using the rpm meter as Table 1.

Tabel 1. Research Data of Hybrid Wind Turbine

Power Supply Voltage (V)	Turbine Rotational Speed (rpm)	Turbine Generator Voltage (mV)
2.5	296.0	8
	284.2	
5.0	366.4	35
	342.8	
7.5	485.3	40
	461.7	

From the results of research data obtained the relationship between turbine speed with the input voltage provided by the power supply. When given a voltage of 2.5 V produced a minimum turbine rotation speed of 284.2 rpm and a maximum of 296.0 rpm. When the voltage is increased to 5 V the minimum speed is 342.8 rpm and a maximum speed of 366.4 rpm. When given a voltage of 7.5 V, a minimum speed of 461.7 rpm and a maximum of 481.3 rpm are produced.

IV. CONCLUSION

The design of a hybrid wind turbine with the incorporation of a Savonius two blades wind turbine with a three blades Darrieus wind turbine has been successfully made. Hybrid wind turbines that have been designed and built on an experimental scale show quite good performance. From the results of experimental data in this study it can be concluded that with a further modification of this design, this Hybrid wind turbine is suitable for use as a small-scale wind power plant.

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