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ORIGINAL RESEARCH

Analysis of The Savonius Type Vertical Axis Wind Turbine Prototype

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Abstract

Wind is a term for moving air. Considering that fossil fuel sources are dwindling, wind has the potential to be used as a source of electricity. A generating system is needed to convert wind into energy. A turbine or often called a windmill is a device that can utilize wind power by converting mechanical energy into electrical energy. Wind turbines are classified as horizontal axis turbines or vertical axis turbines depending on the direction of rotation of the rotor. One of the vertical type turbines is the Savonius turbine. This turbine is very suitable for application in Indonesia because it has several advantages, including being able to rotate at relatively low wind speeds, being able to receive wind from all directions, as well as ease and low construction costs. This research aims to analyze the Savonius wind turbine prototype with 2, 3 and 4 blades. The turbine blade material used is PLA (Polylactic Acid), which is a biodegradable thermoplastic made from cane sugar or cornstarch which is environmentally friendly. Blade dimensions 100 mm x 102 mm x 2 mm. Data collection was carried out by testing at wind speeds of 3 m/s and 4 m/s. Wind speed is kept constant through the windtunnel. Experimental results show that the number of rotor rotations is inversely proportional to the number of turbine blades. Likewise for the turbine power coefficient. The turbine with 2 blades has the best performance compared to the other two turbines.

KEYWORDS:

Blade; Polylactic Acid; Power Coefficient.

1 | INTRODUCTION

Depending on how the rotor spins, wind turbines are sorted as horizontal turbines or vertical turbines. Savonius Turbines are upward plans proper for use in Indonesia. The wind is moving air. Wind speed and course are altogether impacted by territorial geographic elements. Around the world, wind velocities can go broadly from low to high, contingent upon a rise above ocean level [1]. Wind can be utilized as a wellspring of power because of the reduced wellsprings of petroleum products. Wind energy change requires the utilization of a generator framework. One such part is a windmill. By changing mechanical energy into electrical energy, a turbine, frequently known as a windmill, is a gadget that can tackle wind power [2, 3]. Its chief parts are the rotor and blades of the turbine. The wind is caught by blades, which makes the rotor turn. The Savonius type was created in 1929 by Finnish architect SJ Savonius. The Savonius-type windmill has a few advantages, including simplicity of building and low development costs. It can likewise work with low wind speeds and can get wind from all bearings. The Savonius wind turbine has a high starting force at low wind speeds [4]. This sort of turbine is ideal for use in Indonesia, where the average wind speed is in the range of 3 and 7 m/s [5].

2 | PREVIOUS RESEARCHES

One of the research on the Savonius turbine was completed by Mohamed et al. [6] who zeroed in on the suitable blade type of the adjusted Savonius turbine. The Savonius windmill's exhibition works on by something like 30% for TSR values in the range of 0.3 and 1.4. Saha et al. [7] concentrated on the Savonius curved blades windmill. As a result, the most elevated Cp acquired was 13.99%. The wind that is caught will rotate the rotor and push the blades. Turbine power is fundamentally affected by wind speed. The performance of the Savonius turbine is shown by Cp, following the following equation [8]. The power created by the turbine to the wind power is communicated as a proportion, or Cp, utilizing the accompanying formula:

$$C_p = \frac{P_{\text{out}}}{P_{\text{in}}} \tag{1}$$

$$P_{out} = T\,\frac{2\pi n}{60} \tag{2}$$

Information

- P_{out} = power delivered by the turbine
- T = torque (Nm)
- n = number of rotor rotations (rpm)

The P_{in} is the power because of the wind pushing the blades and moving the rotor, as displayed in the accompanying condition [9].

$$P_{in} = \frac{1}{2}\,\rho\,A\,v^3 \tag{3}$$

Information

- P_{in} = wind power (Watt)
- ρ = density of air (kg˙m^3)
- A = cross-sectional region (m^2)
- v = wind speed (m˙s)

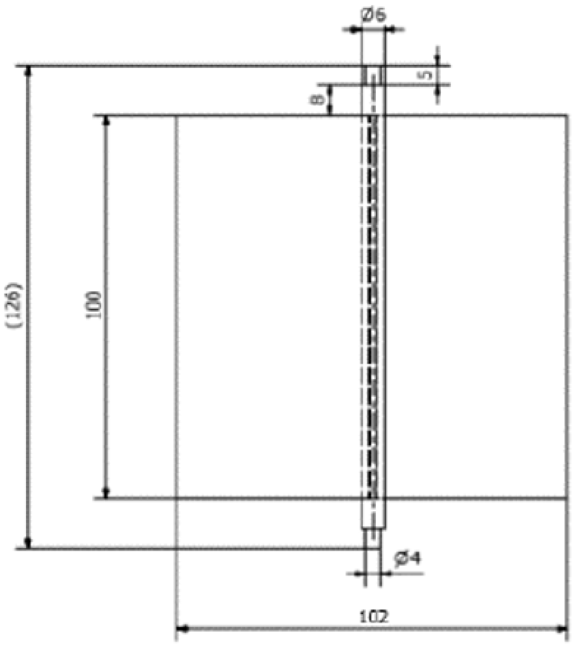

FIGURE 1 Dimensions of wind turbines.

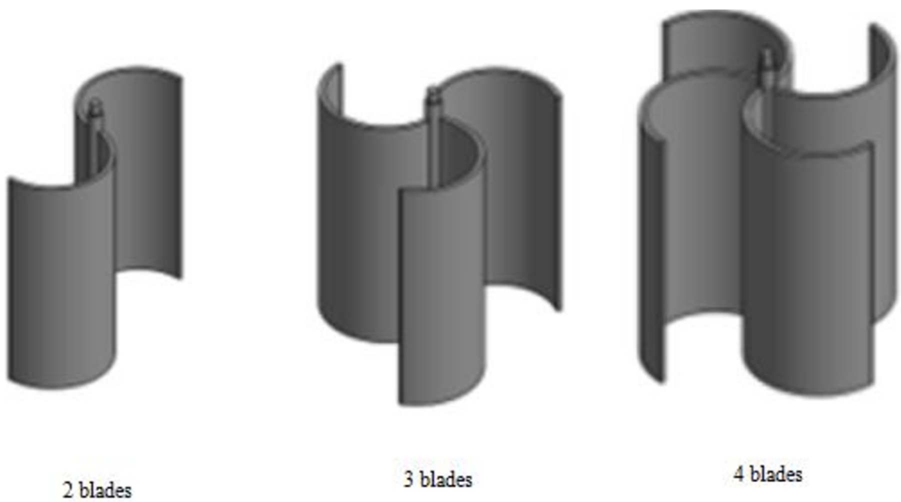

FIGURE 2 Schematic drawing of turbine blades.

3 | METHOD

The Savonius wind turbine's U sort filled in as its model. Polylactic Acid (PLA), a biodegradable thermoplastic made from raw sweetener or cornstarch, is the essential substance utilized in this item. The turbine profile is shown in Figure 1 .

Dimensions of the turbine sharp blades are 100 mm x 102 mm x 2 mm. Heading is embedded at the two closures of the shaft to save the soundness of the rotor turn. The schematic shown in Figure 2 illustrates that the number of blades can be 2, 3, or 4.

The analyses used for model testing follow the flowchart shown in Figure 3 .

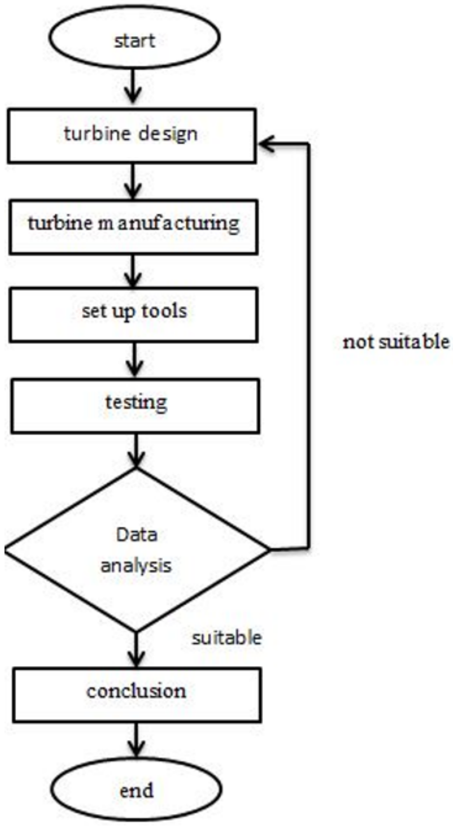

FIGURE 3 Flowchart diagram.

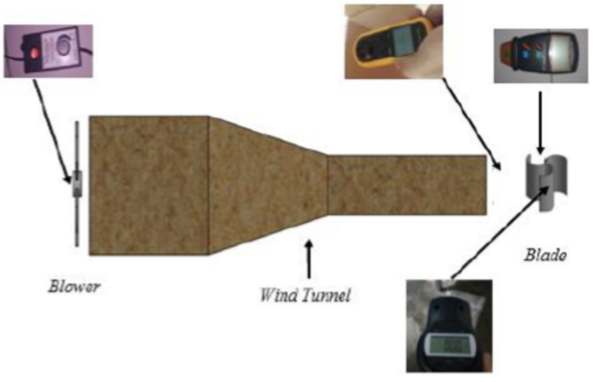

FIGURE 4 Research scheme.

Making a model of the Savonius turbine was the most vital phase in the examination cycle. The device was then set up for testing. A steady wind speed was used to rotate the rotor and drive the blades through the airflow. The test procedure is shown in Figure 4 .

A tachometer was utilized to quantify pivoting speed (rpm), an anemometer to quantify wind speed, and a power check to gauge wind force. Following the information experiment, ends are made.

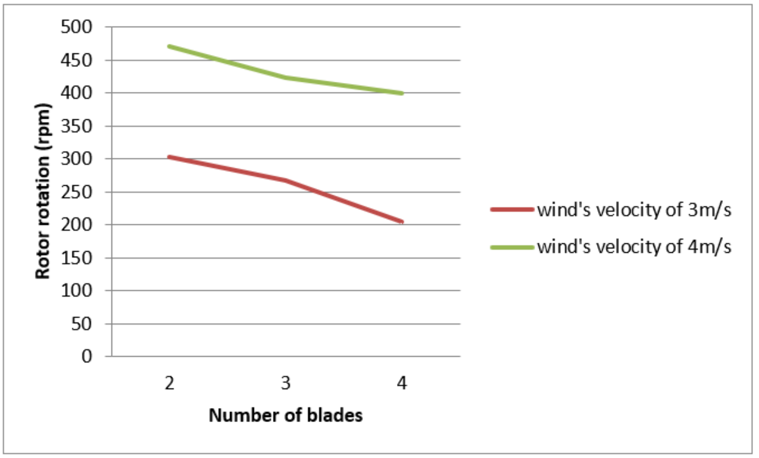

FIGURE 5 Testing of rotor rotation with wind velocities of 3 and 4 m/s.

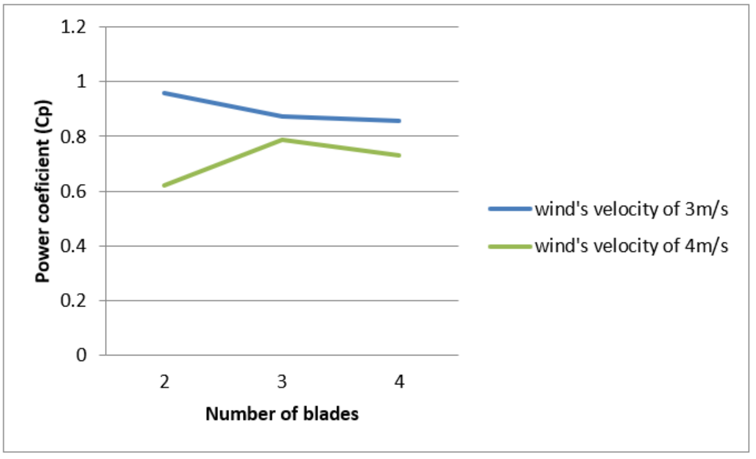

FIGURE 6 Testing the power coefficient with wind speeds of 3 and 4 m/s.

4 | RESULTS AND DISCUSSION

According to a streamlined viewpoint, the Savonius drag turbine is the most clear. Normally, the turbine has two, three, or four vertical semi-roundabout cutting edges. On this turbine, there are a few powers following up on every sharp edge. The rotor begins to turn accordingly. A few sharp blades act as wind catchers, while others act as windbreaks. The rotor's turning is influenced by the breeze's speed. The breeze speed will make the rotor more rapid.

As shown in Figure 5 , the rotor rotation is inversely proportional to the number of turbine blades. An increase in the number of blades results in a decrease in rotor rotational speed. Rotor rotation is influenced by the number of blades that resist the wind. The difference between the thrust acting on the wind-retaining blades and the thrust acting on the wind-receiving blades determines the magnitude of the torque on the rotor and its rotational speed (rpm) [10, 11]. Consequently, a turbine with a greater number of blades produces lower rotor rotation. Turbine performance based on the power coefficient (Cp) is shown in Figure 6 .

Wind turbine performance is assessed using the power coefficient, or Cp. According to Akwa et al. [12], this coefficient represents the output power compared to the input power. The actual power produced by the turbine is divided by the wind power. The actual power is closely related to the number of rotations of the rotor. Power is proportional to the rotation of the rotor. In proportion to the number of rotations of the rotor, the actual power generated by the turbine is also greater. In Figure 6 above, it can be seen that the power coefficient is inversely proportional to the number of blades. The more the number of blades, the smaller the power coefficient. Turbine with two blades shaped like the letter S. One blade acts as a wind catcher and the other blade as a windbreak. Likewise for turbines with three or four blades. The two-blade turbine is 1800 apart between the blades. Meanwhile, for the three-blade turbine, the blades are 1200 apart, and the four-blade turbine is 900 apart. Not all of the wind power received by the blades is used to rotate the rotor, but some of the wind power is used to drive the blades which hold the wind, as a result the efficiency of the savonius type turbine is low [11]. The power coefficient displays the amount of wind energy that can be converted from wind kinetic energy through the cross section of the turbine rotor [13].

5 | CONCLUSION

Based on the experimental results, it was found that the rotor rotation and the power coefficient of the two-blade turbine were the greatest. It is concluded that the turbine with 2 blades has the best performance compared to other turbines.

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