Effect of Adding of Pitch on the Darrieus Blade Against the Cut In Speed of the Savonius Type S - Darrieus Type H Hybrid Turbine

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Abstract. This research was aimed to analyze the effect of adding pitch angle to the performance of a Savonius Hybrid Type S-Darrieus Type H-Rotor wind turbine with variations in wind speed. This research used an experimental method with variations in pitch angle and wind speed. Variables taken in this study are wind speed, pitch angle addition, and wind turbine cutting speed. Variations in the addition of pitch angles are 0°, 5°, 10°, 15°, 20°, 25°, 30°. The results showed that the addition of pitch angles to the blade influenced the cut in speed. The highest cut in speed is 4.2 m/s at the addition of pitch 0° while the lowest cut in speed is at 3.8 m/s at the addition of a 30° pitch angle.

Keywords: cut in speed, pitch, speed , hybrid Savonius - Darrieus

1. Introduction

Indonesia has an increasing need for energy every year. Potential fossil energy resources include petroleum gas and coal. In 2018 oil production will be 448.4 million barrels, natural gas 7.5 million tons and coal 200 million tons while energy needs in Indonesia include 456.7 million barrels of oil, 7.5 million tons of natural gas, 115 million tons of coal, and 115 million tons of coal. Fossil energy production in Indonesia will be reduced, especially petroleum which will increasingly run out while new main sources are relatively limited. Therefore the government and the private sector strive to generate new and renewable energies to maintain the country's energy needs [1].

New renewable energy (EBT) is defined as energy that can be renewed and cannot be used up. Renewable energy includes water, geothermal, bioenergy, solar, wind, and sea energy. According [2] the advantage of renewable energy is that it is relatively easy to obtain free of charge, does not cause global warming, and is not affected by rising fuel prices.
The potential of new renewable energy (EBT) in Indonesia is very large to reach 442 GW, but currently the renewable new energy that can be produced by Indonesia is only
8.8 GW or 14% of the total electricity generation which is 64.5 GW [1].

Wind energy as an energy source for electricity generation. Wind energy is an energy source that is available at all times and has a profitable business future now most developed countries in Europe and the United States have utilized this energy source [3]. Wind energy can be renewed, can be made, the amount is very abundant, and does not cause air pollution that pollutes the environment even though it is continuously used.

The Potential of New and Renewable Energy (EBT) in Indonesia, especially wind energy, is currently not fully utilized. Mapping the potential of new renewable energy shows that from wind resources 60.6 GW the potential available is only 18.75 MW or only around 0.0165% [1]. Wind energy can be utilized for electricity generation, by using wind energy conversion which is commonly used, namely wind turbines.

Therefore, research on the use of wind turbines in Indonesia continues. There are several reviews of Savonius-Darrieus hybrid designs that commonly affect SavoniusDarrieus turbine

performance including bucket number, blade configuration, rotor stages, buckets and rotor shapes (blade and rotor shapes) , and other modifications [4]. All modifications are made to increase the angular speed and maximum torque that can be produced by the Savonius - Darrieus turbine. This study analyzes variations in the addition of pitch (angle) to the blade to the cut in speed of a Savonius Type S - Darrieus Type H - Rotor hybrid wind turbine. Cut in speed (initial rotation speed) is the ability of a wind turbine to spin from rest at a certain wind speed.
Specifically Savonius-Darrieus is hybridized because the Darrieus turbine has a high cut in speed but a large power coefficient while Savonius has a low cut in speed but a small power coefficient, and a low tip speed ratio from a low speed ratio. The main disadvantage of hybrid configurations is the increased complexity of geometry, a way in which two Savonius-Darrieus are combined to be important to maximize the performance of a combined rotor, compared to a single component [5].

In the research, variations in the addition of the Darrieus pitch as another form of modification to improve the performance of the Savonius - Darrieus hybrid turbine so as to obtain the best cut in speed. In the study, variations in the addition of the Darrieus blade pitch as another form of modification to improve the performance of the Savonius - Darrieus hybrid turbine so as to obtain the best cut in speed.

2. Research Methods

The research method used is the experimental method [2]. The activities carried out in this research include the study of literature, tools and materials, experiment setup, data collection, and data analysis. Data is collected by measuring and recording the wind speed when the turbine starts rotating for each variation in the number of pitches on the blade. Data analysis was performed using quantitative descriptive analysis techniques with a comparative approach. The variation of wind speed used is 1.5 m/s to 5 m/s at an interval of 0.1 m/s. The addition of pitch variations used are 0°, 5°, 10°, 15°, 20°, 25°, 30° pitch. The research instrument to obtain data from the independent variables are the turbine blade and the number of pitches.

In the research design, an anemometer is used to measure the wind that occurs during testing. Anemometer mounted on the turbine frame to determine the wind speed that blows. The next step is to vary the number of pitches alternately. During the experiment the wind speed was recorded when the wind turbine had started to spin from rest. The large wind speed when it starts to spin is used as the basis for determining cut in speed.

Data was collected for 13 days from the 16th April to 3th May 2020 at 08.30 a.m. to 05.00 p.m. in cloudy weather conditions. Retrieval of test data is done by taking 7 data from each value of the wind speed in an interval of 0.1 m/s. Data taken is then averaged to be the final result of each treatment.

2.1. Savonius - Darrieus hybrid turbine blade design

The Savonius-Darrieus hybrid design in this study uses Savonius in the middle of the Darrieus on the outside as shown below (cm units):

Figure 1. Savonius - Darrieus hybrid turbine

2.2. Pitch design on the Darrieus turbine blade

Pitch is an additional part or modification to the turbine blade which serves to increase the turbine rotation so that the rotation becomes more optimal. This study uses 3 blades with variations in the addition of pitch as shown below (cm units):

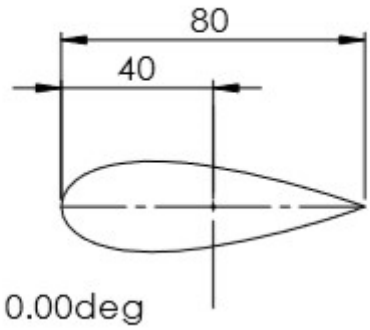

Figure 2. 0° pitch

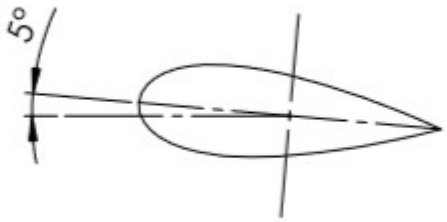

Figure 3. 5° pitch

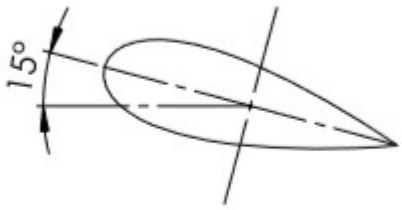

Figure 4. 15° *pitch*

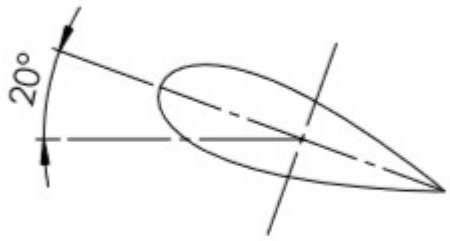

Figure 5. 20 ° *pitch*

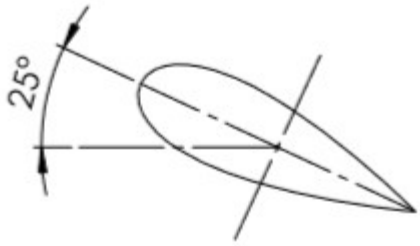

Figure 6. 25 ° *pitch*

Figure 7. 30° *pitch*

3. Results and Discussion

Cut in speed is the ability of a wind turbine to spin from rest at a certain wind speed. In **Figure 9.** The Savonius-Darrieus hybrid wind turbine shows that without pitch or pitch at wind speeds of 3 m/s a cut-in speed cannot yet occur.

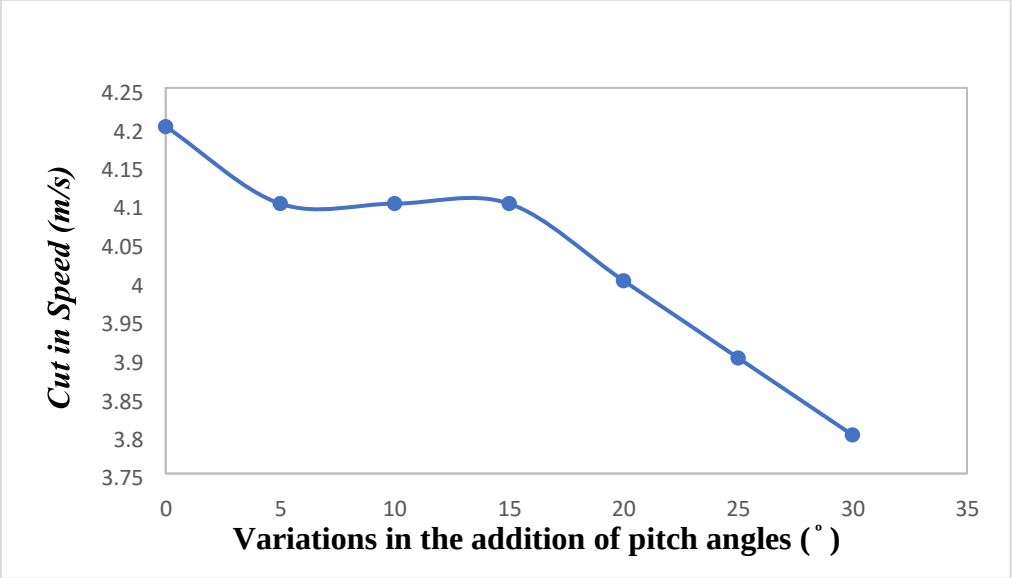

Figure 8. Cut in Speed Graph

Figure 8 shows that the greater the pitch angle, will make the turbine blade easier to rotate at a lower speed than the others. Wind turbines with variations in the addition of a 30˚ pitch angle have a lower cut-in speed. In wind 3.8 variations in the addition of pitch angles of 5˚ and 10˚ produce a cut in speed of 4.1 m/s. This shows that the greater the pitch, increases the ability to cut in speed.

The increase in cut-in speed occurs along with the increase in pitch because the area of sweeping space on the Darrieus blade is greater so that the thrust increases and the wind turbine will be easier to spin. This causes the wind to push the turbine to be more efficient in other words the focused wind pushes the turbine blade.

The results of this research are supported by the results of research conducted [6] which states that increased power and efficiency occur along with an increase in pitch angle on Darrieus. At a certain pitch angle, the energy will reach its optimum point and then it will decrease.

The results of this research are also supported by the results of research conducted [7] which states that the addition of the highest pitch and fin in Savonius blade has the lowest cut in speed in Savonius wind turbines. The addition of fins to the Savonius turbine blades and the addition of pitch to the Darrieus turbine blades so that the wind is more focused and directed at the turbine blades. Adding fin and pitch to the Darrieus turbine blade has the same function.

The more pitches added to the blade, the better the turbine cut-in speed can be. This indicates the turbine is able to produce useful electrical power at lower wind speeds. The ability to cut in speed is influenced by many factors including the dimensions of the turbine rotor, turbine height, and modification of the rotor tubin. However, the most influencing factor is the dimensions of the turbine rotor and generator used. The good ability to cut in speed is not necessarily good at certain wind speeds because the cut in speed is from a standstill to a spin.

4. Conclusions

There is an effect of adding pitch to the cut in speed of Savonius - Darrieus hybrid wind turbines. The greater addition of pitch angle to the turbine blade will increase the cut in speed capability of the wind turbine. Variation in addition of pitch angle 300 has the lowest cut in speed (best) of 3.8 m/s while variation of addition of pitch pitch 0˚ has the highest cut in speed of 4.2 m/s. Variations in the addition of pitch angles of 25˚ and 20˚ have a cut in speed of 3.9 m/s. Variations in the addition of pitch angles of 15˚, 10˚, and 5˚ have a cut in speed of 4.1 m/s. The increase in pitch occurs because the area of sweep space on the Darrieus blade is greater so that the thrust is increased and the wind turbine will be easier to spin.

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