# Characteristics of the Savonius Turbine to Variation Angles

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***Abstract*— Wind energy is a form of energy that can be converted into electrical energy using a wind turbine. Based on the axis of rotation, wind turbines are of two types, namely horizontal axis wind turbines and vertical axis wind turbines. Wind turbines with a vertical axis have several types including Darrieus wind turbines, Savonius wind turbines, and H wind turbines. The purpose of this manufacture and test is to determine the effect of wind speed and system efficiency from the Savonius 8 blade wind turbine with variations in the angle of attack on wind speed. certain. Based on the test results, it can be seen that the highest generator power value is at a wind speed of 6 m/s worth 3.85 Watt with an angle of attack of 20° and a load of 1 DC lamp, a wind speed of 7 m/s worth 5.58 Watt with an angle of attack of 0° and a load 3 DC lamps, wind speed of 8 m/s worth 8,52 Watts with an angle of attack of 5° and a load of 4 DC lamps. While the highest system efficiency value is obtained at a wind speed of 6 m/s worth 4,62 % with an angle of attack of 20° and a load of 1 DC lamp, a wind speed of 7 m/s worth 4,218 % with an angle of attack of 0° and a load of 3 DC lamps, wind speed 8 m/s worth 4,31 % with an angle of 5° and a load of 4 DC lamps.**

***Keywords*— *Savonius turbine, wind speed, generator power, efficiency.***

## I. Introduction

. Electrical energy has become a primary need in human life, almost every aspect of human life involves electricity in it. With the increasing population and rapid economic and industrial growth, the demand for electrical energy in Indonesia has also increased significantly. To overcome the increasing demand for electricity, there is a need for innovation in terms of renewable energy. Based on the results of mapping the distribution of wind speeds carried out by the Meteorology, Climatology and Geophysics Agency [BMKG] and measurements from the Geological and Marine Development Research Center [P3GL-KESDM], high wind speeds [6 - 8 m/s] onshore occur in the southern coast of the island of Java, South Sulawesi, Maluku and NTTWhile wind speeds in the offshore area show figures of more than 8 m/s occurred in Offshore Banten, offshore Sukabumi, offshore Kupang, offshore Wetar Island, and offshore Jeneponto District, and offshore Tanimbar Islands District. The maximum wind speed occurs in the period June, July, August [JJA] when the Australian monsoon occurs while the minimum occurs in the period March, April and March [MAM] when the Asian monsoon transitions to the Australian monsoon.

Then previous research mentioned a wind speed of 5 m/s with a blade angle of 0, which is 150.6 rpm [1], this was strengthened by research related to other savonius turbines which stated that the power value of the generator is directly proportional to the rotation of the turbine. The greater the turbine rotation, the greater the generator power produced [2]. Wind turbines are generally divided into two types based on the orientation of the turbine shaft rotation, namely wind turbines with a horizontal axis and wind turbines with a vertical axis [4]. Vertical axis wind turbines have the main rotor axis or shaft arranged perpendicularly. One type of TASV wind turbine is the Savonius turbine. The main advantage of this type of turbine is that the turbine blades do not have to be directed to the wind to generate electricity. This advantage is very useful considering the varied wind potential in Indonesia [5][9][10][11]. There is research on one-level savonius with a number of blades 4 and 6 to get the maximum Cp value at 27.88% on 4 blade blades with a speed of 3 m/s [6]. Studies with 4 blades were also carried out and yielded the best results [7]. savonius research with angle variations has also been carried out to find that with an angle of 22.5 degrees it produces a relatively high rotational speed [8]. In fact, by varying the Power Ratio, the Efficiency is also different [12] and where it is known that the prototype model of the Savonius wind turbine started rotating at a wind speed of 2.4 m/s. Furthermore, other studies were also carried out by testing savonius with 8 curved blades [14] and research by comparing the types of helical savonius and savonius blades showed that the type of helical savonius rotor type was the best [15]. Based on the description above, researchers will conduct experiments by varying the angle to determine the characteristics of the savonius wind turbine.

## II. Methods

In this study, several stages were conducted, which are presented in the research flowchart shown in Figure 1.



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Fig.1. Flowchart of Research

In testing several parameters used include wind speed, generator mass, turbine rotation, voltage and electric current. These data are used to calculate torque, kinetic power, mechanical power, electrical power, turbine efficiency, and system efficiency. All data obtained is presented in the form of tables and graphs of characteristics, so that it can be used as material for discussion and analysis.

The data analysis stage can be carried out after data collection. The test data is then processed and presented in the form of tables and graphs which can then be analyzed. The resulting table consists of 2 tabular forms, namely the test results table and the calculation results table. While the graph presented is a graph of the relationship between turbine rotation (rpm) and generator power (Watts) as well as the relationship between turbine rotation (rpm) and system efficiency (%).

TABLE 1. TEST RESULTS DATA

| Attack Angle | A ($m^2$) | D (m) | H (m) | ρ ($kg/m^3$) | N (rpm) | v (volt) | I (A) | Load |
|---|---|---|---|---|---|---|---|---|
| x | x | x | x | x | x | x | x | x |
| x | x | x | x | x | x | x | x | X |

## III. Results and Discussion

This research was conducted by first determining the location in Politeknik Negeri Semarang

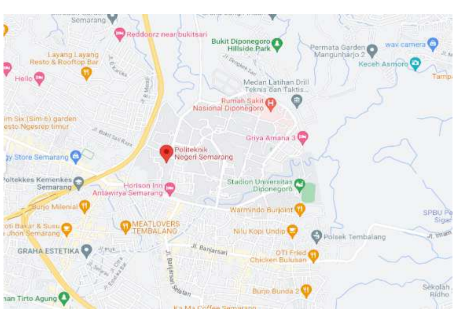

Fig. 2. Research location

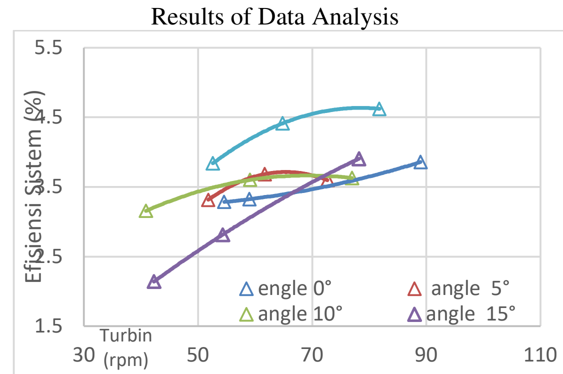


Fig. 3. Graph of Correlation between Turbine Speed (rpm) and System Efficiency (%) at a Wind Speed of 6 m/s

Fig. 4 is a graph of the relationship between turbine rotation and system efficiency at 6 m/s. At angle of attack 0° the highest system efficiency is 3.85% with turbine rotation 89 rpm load 1 DC lamp, angle 5° highest system efficiency is 3.68% with turbine rotation 61.7 rpm load 2 DC lamps, angle of attack 10° highest system efficiency of 3.62 % turbine speed 77 rpm load 1 DC lamp, angle of attack 15° highest system efficiency value 3.90 % with turbine rotation 78.2 rpm load 1 DC lamp, angle of attack 20° highest system efficiency value 4 .62% with a turbine rotation of 81.8 rpm load of 1 DC lamp. It can be seen that from all angles of attack at a wind speed of 6 m/s the highest system efficiency value is obtained at an angle of attack of 20° with a turbine rotation of 81.8 rpm with a load of 1 DC lamp.

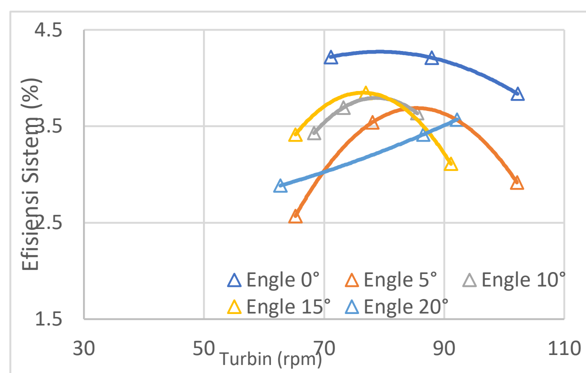


Fig. 4. Graph of Correlation between Turbine Speed (rpm) and System Efficiency (%) at a Speed of 7 m/s

Fig.4 is a graph of the relationship between turbine rotation and system efficiency at a speed of 7 m/s, it can be seen that the resulting system efficiency value is affected by the generator power and kinetic power values, where the generator power value is affected by the turbine rotation value. At angle of attack 0° the highest system efficiency is 4.21% with turbine rotation 71.1 rpm load 3 DC lamps, angle 5° highest system efficiency is 3.54% with turbine rotation 78 rpm load 2 DC lamps, angle of attack 10° highest system



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efficiency of 3.69 % turbine rotation 73.2 rpm load 2 DC lamps, angle of attack 15° highest system efficiency valued 3.84 % with turbine rotation 76.9 rpm load 2 DC lamps, angle of attack 20° highest system efficiency value of 3.65% with a turbine rotation of 92.1 rpm load of 1 DC lamp. It can be seen that from all angles of attack at a wind speed of 7 m/s the highest system efficiency value is obtained at an angle of attack of 0° with a turbine rotation of 71.1 rpm with 3 DC lamps.

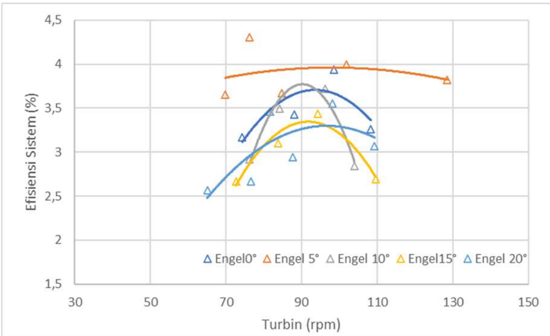


Fig. 5. Graph of Correlation between Turbine Speed (rpm) and System Efficiency (%) at a Speed of 8 m/s

Fig.5 is a graph of the relationship between turbine rotation and system efficiency at a speed of 8 m/s. It can be seen that the resulting system efficiency value is affected by the generator power value and kinetic power, where the generator power value is affected by the turbine rotation value. At angle of attack 0° the highest system efficiency is 3.93% with turbine rotation 98.5 rpm load 2 DC lamps, angle 5° highest system efficiency is 4.31% with turbine rotation 76.2 rpm load 4 DC lamps, angle of attack 10° the highest system efficiency is 3.71% turbine rotation 96.2 rpm load 2 DC lamps, angle of attack 15° highest system efficiency is 3.43% with turbine rotation 94.3 rpm load 2 D lamps, angle of attack 20° efficiency the highest system value is 3.55% with a turbine rotation of 98.2 rpm with 2 DC lamps. It can be seen that from the overall angle of attack at a wind speed of 8 m/s the highest system efficiency value is obtained at an angle of attack of 5° with a turbine rotation of 76.2 rpm load of 4 DC lamps.

## IV. Conclusion

The highest system efficiency value at a wind speed of 6 m/s was obtained at 4.62% at an angle of attack of 20° and a load of 1 DC light, at a wind speed of 7 m/s the highest system efficiency value was obtained at 4.218% at an angle of attack of 0° and a load 3 DC lamps, while at a speed of 8 m/s the highest efficiency value was obtained at 4.31% at an angle of attack of 5° and a load of 4 DC lamps

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