Modification and Testing of Wind Turbine with Double Savonius

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***Abstract*—Indonesia geographically located at tropical region where the wind is very fluctuate and relatively slow. Therefore it is important for designer to investigate the proper design of the slow wind speed turbine that applicable in Indonesia. In this paper, Savonius wind turbine is selected and modified with double level to explore its capability in generating voltage. The main aim of this study is to investigate the performance of the double Savonius turbine in term of its capability in generating voltage. In experimental test, it can be obtained that the double Savonius Turbine could effectively generate 12V at 3 m/s and 17V at 5.4 m/s.**

Keywords*— *Double Turbine; Savonius and Wind Turbine

I. Introduction

Wind energy is one of clean, friendly to environment energy sources, abundantly available naturally and free to use for energy [1]. The application of wind as source of energy is started since long time ago. It was recorded that wind had been used for sail at Nil river since 5000 BC. Application on other purposes such as drilling had been introduced in Persia, Egypt and China in 7th Century and its application as electric power source was boomed at the beginning of 19th century in Europe [2].

According to [3], wind characteristic in Indonesia varies from 2.7-4.5 m/s where it is categorized as low wind speed with common turbulence. One of wind turbine type is Vertical Wind Turbine (VWT), where the main rotor is located perpendicularly. The main advantage of VWT is that no vane or tail is required to direct the turbine on wind direction. This function is very suitable for the area where the wind direction is changing rapidly. One of VWT turbine that is well known widely is Savonius. This wind turbine type is applicable on low speed wind because it could produce sufficient torque [4]. To improve the capability of Savonius in extracting energy from the wind, double Savonius is introduced in this paper to investigate the performance of the turbine in generating voltage. Typical model of Savonius is shown in Figure 1.

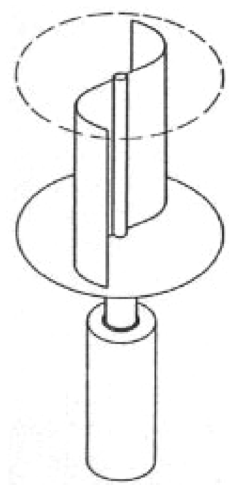

Figure 1. Typical model of Savonius

Savonius type was introduced first by Sigurd J. Savonius in 1922, an Finlandia Engineer. This turbine is a drag type where the energy is produced simply by harnessing the drag force that is opposite direction with the blades [5].

The fundamental equation used for wind energy extraction is:

$P = \dot{-}$ ……………………………….. (1)

Where:

P is Generated Power (W),
ρ is air density (kg/m^3),
A is swipe area in (m^2),
v is wind velocity in m/s.

II. Research Methodology

A. Location and Research Time

The data was collected at Tanjung Merdeka Beach, Tamalate District, Makassar, Indonesia. The data was collected from 27th to 30th September 2015, started from 08.30 to 18.30 Center Time of Indonesia (CTI).

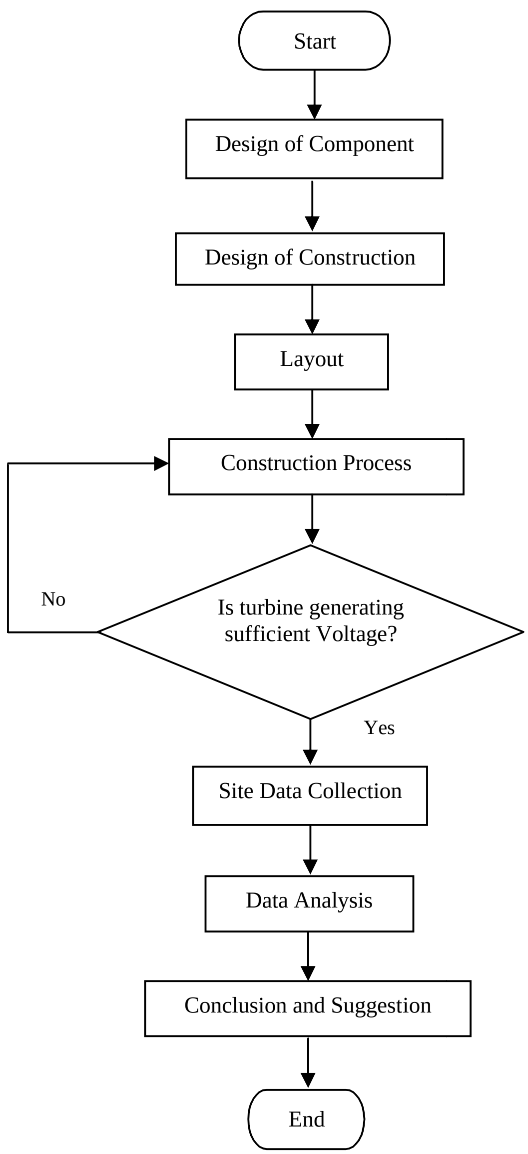

Figure 2. Research Stages

B. Double Savonius Design

The stage of design can be seen in Figure 2. The layout of double Savonius is shown in Figure 3.

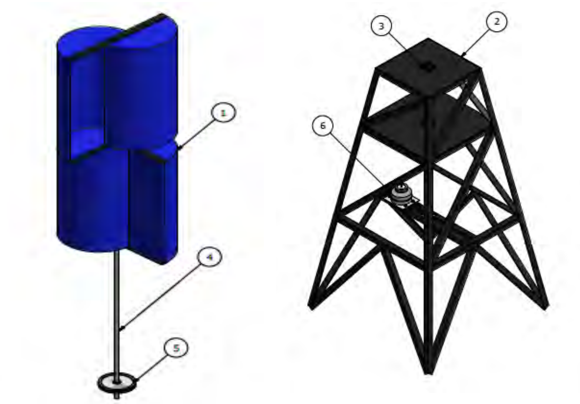

Figure 3. Design layout of the double Savonius

Where:

1. Turbine's Blades
2. Turbine's Support
3. Bearing
4. Turbine's Shaft
5. Pulley
6. Generator

Figure 4. Real construction of the double Savonius

III. Results and Discussion

The dimension of the designed double Savonius can be described in Table 1.

Table 1. Dimension Information of Designed Turbine

Blades	
a. Head	180 cm
b. Diameter	82.5 cm
Support	
a. Head	200 cm
b. Wide	120 cm
Shaft	
a. Diameter	2.1 cm
b. Shaft Lenght	310 cm
Pulley	
a. Diameter	23 cm
Bearing	
a. Diameter	2.1 cm
Rated V: Generator AC 1 Phase	220 V

Tabel 2. Hasil Pengukuran Turbin Angin Savonius Tipe Tingkat

No.	Wind Speed (m/s)	$N_{generator}$ (Rpm)	Charging Voltage (V)	Phase Voltage (V)	Measured Current (A)
1	3.2	41	13	14	0.02
2	3.2	49	12	13	0.03
3	3.2	53	12	13	0.03
4	3.4	65	13	14	0.03
5	3.7	66	13	15	0.04
6	3.8	74	14	15	0.05
7	3.6	75	14	17	0.06
8	3.4	79	14	17	0.07
9	3.8	80	13	15	0.08
10	4.2	87	15	19	0.09
11	3.5	95	15	19	0.08
12	4	99	14	18	0.14
13	4.2	102	14.5	18	0.1
14	4	103	14	19	0.12
15	4.1	106	15	20	0.06
16	5	115	14	20	0.14
17	5	118	15	23	0.12
18	5.5	123	16	23	0.18

Table 2 shows the performance of the double Savonius in terms of generated voltage in accordance to wind speed.

The performance of the testing stage of the double Savonius can be seen in Figure 5 to 9.

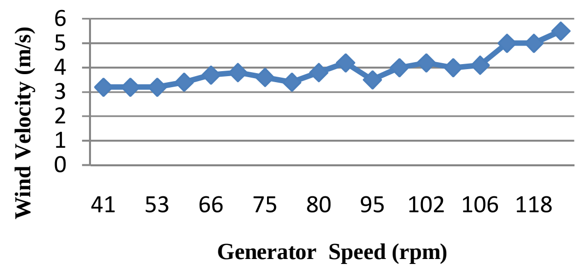

Figure 5. Trend of wind speed vs generator speed

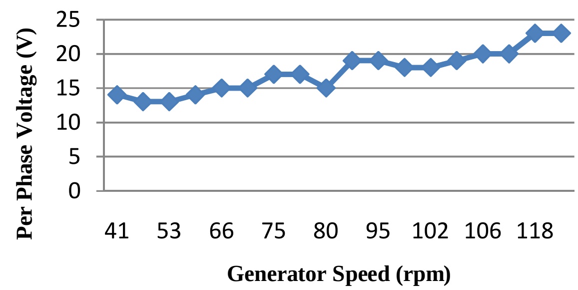

Figure 6. Trend of per-phase vs generator speed

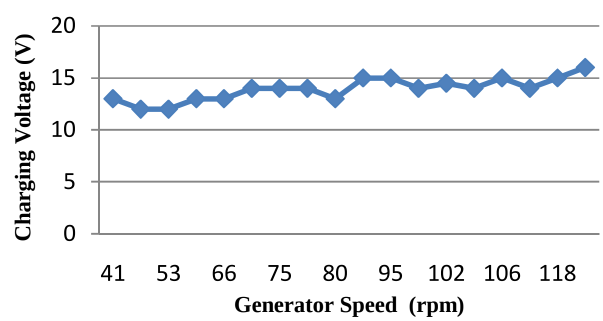

Figure 7. Charging phase vs generator speed

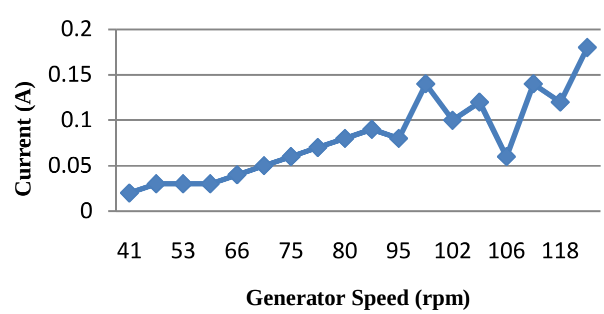

Figure 8. Current vs generator speed

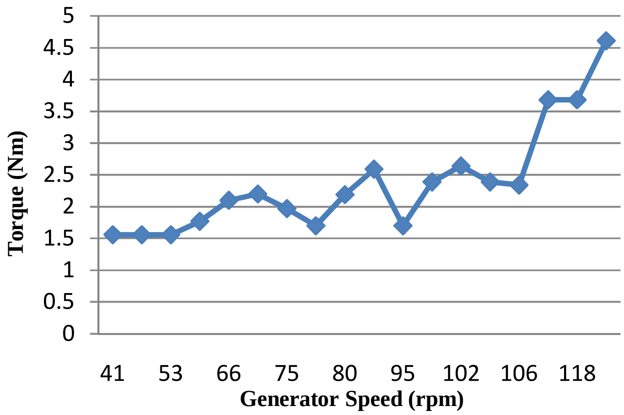

Figure 9. Current vs generator speed

It can be seen from Figure 5 to 9 that when wind speed increased, the other parameters are also raised gradually. It was measured that starting point of this double Savonius could generate voltage is 3 m/s and resulting about 12V whilst the maximum voltage could be generate is 17V at the wind speed of 5.4 m/s. The small fluctuation occurs due to the fact that data was taken per hour and not in continuous ways. It can be seen in Table 2 that some wind speed values have the same values but in rpm measurement come with small differences. This occurs due to the fact that wind speed intermittently influences the starting torque of the double Savonius. For simplicity of analysis, data that was collected in 4 days is sorted from the lowest to the highest wind speed.

IV. Conclusion

From the testing results, it can be concluded that double Savonius could generate about minimum 12V at speed of 3.0 m/s and maximum 17 Volt at 5.4 m/s. With minimum 12V of charging voltage it is sufficient to charge an accu after rectifying.

Acknowledgement

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