

Investigation Rotational Speed on Savonius Wind Turbine Blade Design

M.S. Kasim^{1*}, G. Wan¹, R. Izamshah¹, Y. Shukri², M.S.M Suan¹, N. Mohamad¹, A. Lamat³ and S.B. Mohamed⁴

¹Centre of Smart System and Innovative Design (CoSSID),
Fakulti Kejuruteraan Pembuatan, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

²Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

³DEF Advance Technologies, No. 12-1, Jalan CP2, Taman Cheng Perdana 1, 75250 Cheng, Melaka, Malaysia

⁴Faculty of Innovative Design and Technology, Universiti Sultan Zainal Abidin,
21300, Kuala Terengganu, Terengganu Darul Iman, Malaysia

*Corresponding e-mail: shahir@utem.edu.my

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ABSTRACT –Wind turbine is one of alternative source of renewable energy. This study aims to investigate a few Savonius wind blades to identify the relation between the blade patterns and their performance under-tested low wind conditions. The Savonius wind blades are organized into four major parts: the number of blades and twist angle. The field of the study has implemented the prototype for the exhausted air system, such as the home air-conditioner blower. Following the test, the wind blade with two blades with a 180° angle of twist shows a better rpm value and the highest efficiency of 79.23%.

1. INTRODUCTION

Scarcity of natural resources has led to high demand on renewable and sustainable energy. Wind energy has become one of energy alternative source. It has several advantages and benefits; fewer effect on the environment by not release polluted emission [1,2]. Urban wind energy is a great potential source that currently underutilized [3]. However, there are a few limitations in wind energy technology implementation, such as it will effect to local wildlife, specific location that having good wind speed condition that often located in remote area, and several issues related to noise and aesthetic pollution [4]. In Malaysia It has been observed that wind direction changes seasonally by monsoon, and that it does not show a uniform behavior. The average wind speed is usually below 3 m/s, which insufficient for generation of wind energy continuously [5,6]. The vertical axis wind turbines (VAWTs), is one of the solutions where the wind blade patterns are constructed by a combination of the Savonius and Darrieus rotors. This design improves the wind energy extraction that enable to rotate from various wind directions [7]. The Savonius wind blade is a Vertical Axis Wind Turbine (VAWT) type wind blade pattern, it is a unique form of power generating technology. Current studies prove it has better efficiency in low wind speed conditions and multi direction [8].


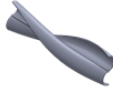
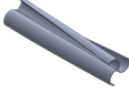
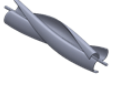
In this study, the Savonius wind blades with various configurations and conditions are tested to evaluate the blade speed under low wind speed. The blade that possess high speed then can be accommodated to other

studies related to energy harvesting.

2. METHODOLOGY

The Savonius wind blade prototypes are fabricated in four groups using the 3D printing. The blades themselves have dimensions of 100 mm in diameter with a length of 400 mm. Each blade has a different angle of twist and number of blades. Four types of blades that designed are two blades with 45° angle of twist, two blades with 180° angle of twist, three blades with 45° angle of twist, and lastly, three blades with 45° angle of twist (Table 1).

Table 1 Savonius wind blades model

No.	Figure	Number of Blades	Angle of Twist
1		2	45°
2		2	180°
3		3	45°
4		3	180°

The material used for the test specimen is an ABS (acrylonitrile butadiene styrene). The shafts and the connectors pin itself are also made of ABS, which is fabricated using same process of the 3D printing. The filament infill for during the rapid prototyping process is 15% of material infill. The experiment configuration was done as Figure 1. The anemometer device was used

to monitor the wind speed condition when the test was made. The air blower provides a consistent wind speed set at average of 5 m/s. The tachometer measures the output revolution per minute (rpm) from the rotated Savonius wind blades. The reflector sticker with the ability to reflect light was affixed to every blade in order to reflect the signal transmitted from the tachometer.

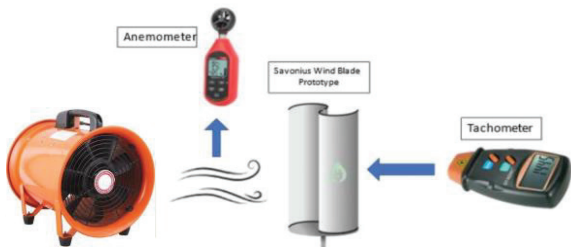


Figure 1 Experiment setup

3. RESULT AND DISCUSION

During the performances testing of the final products on the exhaust air of the air-conditioner blower fan, several tests are being made upon each wind blade sample. Figure 2 shows the overall performances of all designated Savonius wind blades in terms of their ability to turn under fixed low wind speed conditions. The collected data was recorded in revolution per minute (rpm).

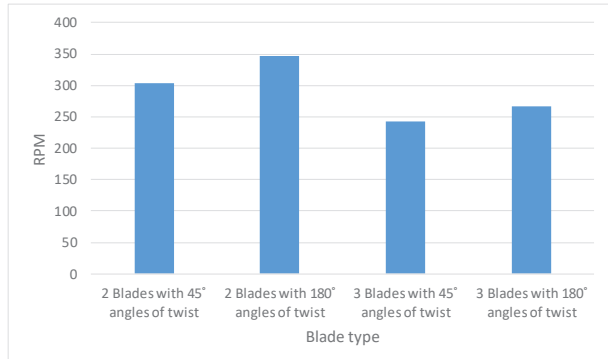


Figure 2 The performances of blades during test

From the collected data above, the recorded revolution per minute (rpm) for the two blades with 45° angles of twist blade type has an average of 303.92 rpm. Meanwhile, the same category of two blades type, which is 2 Blades with 180° tips of twist, has an average of 347.16 rpm. For three blade types, both of 3 blade types which using 45° angles of twist and 180° angles of twist recorded 242.24 rpm and 266.38 rpm, respectively. The highest average of rpm recorded was 347.16 rpm, which was gained from the Savonius type wind blade of 2 blades with 180° angle of twist. The second highest rpm recorded was the Savonius type wind blades of 2 blades with 45° angle of twist, with 303.92 rpm recorded, followed by three blades with 180° angle of twist, 266.38 rpm recorded, and lastly, two wind blade types with 45° angle of twist, which has the least rpm average recorded, which is 242.24 rpm.

4. CONCLUSIONS

The main objectives of this project have been achieved. Several designs of Savonius wind blades with different numbers of blades and angles of twist have been successfully fabricated using the rapid prototyping method. Next, designated Savonius wind blades capable to undergo test using exhausted air from an air-conditioner blower fan, where each of the blades can spin and be competent enough to produce reading data using a tachometer. Lastly, a comparative study between every designated Savonius wind blade can be done experimentally.

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REFERENCES

- [1] S. Yang, and S. Park, The effects of renewable energy financial incentive policy and democratic governance on renewable energy aid effectiveness, *Energy Policy*, vol.145, p. 111682, 2020,
- [2] Hyams M, *Wind energy in the built environment*, Elsevier Ltd., pp. 457-499; 2012.
- [3] F. Noman, G.A. Alkawsi, and D. Abbas, Comprehensive Review of Wind Energy in Malaysia: Past, Present, and Future Research Trends, *IEEE Access*, 2020, Vol. 8, pp. 124526- 124543.
- [4] Advantages and Challenges of Wind Energy | Department of Energy, <https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy>, accessed: 10/8/2022
- [5] N. Masseran, A. M. Razali, K. Ibrahim, and W. Z. W. Zin, Evaluating the wind speed persistence for several wind stations in peninsular Malaysia, *Energy*, vol. 37, no. 1, pp. 649–656, 2012.
- [6] M. H. M. Ashnani, A. Johari, H. Hashim, and E. Hasani, A source of renewable energy in Malaysia, why biodiesel? *Renew. Sustain. Energy Rev.*, vol. 35, pp. 244–257, 2014.
- [7] I. Dincer, M.F. Ezzat, *Renewable Energy Production*, Comprehensive Energy Systems, Elsevier; 2018.
- [8] T.S Francisco, A. Santos, M. Gil, Urban wind energy exploitation systems: Behaviour under multidirectional flow conditions—Opportunities and challenges, *Renewable and Sustainable Energy Reviews*, vol. 24, pp. 364-378, 2013.