

Research on wind power generator with savonius type propeller - the comparison of 2 and 3 blades -

*Rio Shimazu¹, *Moea Nakamura¹, *Yuka Miyawaki¹

1. Wakasa High School

Nowadays in Japan, the cases of natural disasters, such as earthquakes or heavy rainfall, hitting the country has increased a lot. For example, the Great East Japan Earthquake (Richter 9.0) in March 2011, the Kumamoto Earthquake (Richter 7.3) in April 2016, the Northern Kyushu heavy rainfall in August 2019 and the huge landslides that occurred in the Izu area last July. When those disasters happened, power shortages were a problem at evacuation centers because the lifelines such as electricity and water supply were shut down. We therefore focused on the wind power, which uses renewable energy and can generate electricity at night to tackle the problem. However, commonly used wind power generators are effective only if the wind direction is right. So it is difficult to utilize them in areas with weak winds. We took over the previous research from our senior students, because we thought it would be effective to use Savonius-type wind turbines, which can handle wind from all directions and generate electricity even in light winds. On the other hand, Savonius-type wind turbines are less powerful than windmill-type wind turbines and are not suitable for large-scale power generation. However, disasters don't occur in only windy areas. In other words, the Savonius wind turbine will be the best choice to manage the blackout during a disaster that could happen anywhere and at any time.

The final goal of our research is to improve the Savonius wind turbine into a collapsible type so that it can easily produce electricity in the shelters. Since the power generation capacity is currently small and not at the practical stage, our primary goal is to improve the shape of the Savonius-type propeller to capture wind energy more efficiently to increase the power generation capacity. Our hypothesis is that increasing the number of blades on a Savonius-type propeller from two to three would increase the amount of airflow drawn into the generator. The reason why we thought the three blades will be more effective than the two blades is that the resistance will be smaller. The two blades receive the wind perpendicularly but three blades receive the wind obliquely, so that the wind required to turn the blade is smaller.

First, we made turbines of equal weight using the plastic board. Then we compared rotation speed and electricity generation. Comparison of rotational speeds showed that the two blade turbine had a higher rotational speed. We hypothesized that the three blade turbine works well to release the air from inside to outside, but bad at receiving the air from outside to inside because each blade of three blade turbine is smaller than those of the two blade turbine and the cavity size of the generator core is wider.

In the comparison of power, two blades are better than three blades. The maximum power of two blades is $8.72 \times 10^{-4} (\pm 0.90 \times 10^{-4}) \text{ W}$ (100Ω) and the one in three blades is $7.98 \times 10^{-4} (\pm 0.84 \times 10^{-4}) \text{ W}$ (100Ω). However, the results of our experiment didn't gain higher electricity than 0.0041 W which was the result from our senior students. As for the reason for this, we thought that the height of the blade was higher than in previous studies. Then the entire area of the blade could not receive the fan's wind.

At the end of the research, we performed a t-test. We can say that there is a difference in means at 5% significance level. Therefore, the power generation capacity is greater for the two blade turbine.

In the future, in order to confirm that the structure and total area of the blade are not receiving wind, we

would like to visualize the trajectory of the wind using dry ice. Then, can be experiment is conducted with the entire area exposed to the wind.

Keywords: wind power generation