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Research paper

Output Characteristics of Small Wind Power Generator with Three-layer Propeller Type Blade Structure

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Abstract

Background/Objectives: Large wind power generate noise due to the high speed of their long wing tips, and are dogged by substantial investment cost due to cumbersome installation process that can be implemented only for large companies. It is necessary to develop low-cost, high-efficiency and small-sized wind power generator in order to address this problem, thereby enabling individual citizens to have their own wind power generator.
Methods/Statistical analysis: This paper constructed an experimental system by using small wind power generator with three-layer propeller type blade made fromthree aluminum plates, which is 50cm length and 12cm wide, are made at an angle of 120 degrees. And output volatage, current, elecrtrical pwoer and RPM characteristics of small wind power generator according to Blade structure and wind speed.
Findings: The experimental results show that output voltage, current and RPM of the wind generator with three-layered blade structure was increased by 36% and 17%, 42% and 18%, 34% and11% than the wind generator with one-layer blade and two-layer blade structure at maximum wind speed 10m/s, respectively. The proposed three-layered blade was generated at low wind speeds.
Improvements/Applications: The proposed method is looking forward to playing an important role in solving the problems of the present wind power generation like as generation efficiency and expansion of distribution at inland areas having low wind speed.

Keywords: Wind Power, Power generator, Blade, Output, Structure, Generation

1. Introduction

Recently, wind power generation among new and renewable energy sources is in the limelight as clean energy source because it can be available indefinitely and no environmental pollutants are emitted[1-3].Installation and used of wind power generator is expanding all over the world because wind power generation have the advantage of being able to get energy by mechanically converting the energy form the wind only the power of rotation[4]. Especially, the construction of offshore wind power generation farm around coastal areas with high wind speed is being actively promoted.

But, the present wind power generation has the problem that they rely on wind power generator with massive size which is manufactured mainly by large corporations. Large wind power generate noise due to the high speed of their long wing tips, and are dogged by substantial investment cost due to cumbersome installation process that can be implemented only for large companies.

Therefore, it is necessary to develop low-cost, high-efficiency, medium and small-sized wind power generator in order to address this problem, thereby enabling individual citizens to have their own wind power generator. Also, the development of parts of small and city-type wind power generator that is able to generate electricity under low wind conditions like inland areas is required [5-7].

Design and production of blade is a very difficult task and a matter of great important because the blade in parts of power generator is key part driving the power generator which converts kinetic energy of wind into mechanical rotating energy [8-10].

This paper studied the output characteristics of small wind power generator with three-layer blade structure capable of generating power at low wind speeds in order to develop low-cost and high efficiency small wind power generator. It has been confirmed as experimental result that the output characteristics of the proposed blade based wind power generator were improved and electrical power can be generated even at low wind speeds.

2. Blade Production and Experimental Method

Experimental system used in this paper is described in figure 1. One, two and three-layer propeller type blade was developed by using three aluminum plates, which is 50cm length and 12cm wide, are made at an angle of 120 degrees, as shown figure 1.

Stepping motor (Model: P22 NR x B-LNN-NS-00) with a maximum output of 71W was used as small horizontal wind power generator for experiment by changing output connection of the motor that is possible to function as a generator in the role of a motor. Fan blower having maximum wind speed of 12m/s was used as wind speed generator.

The wind power generator was fixed at 170cm above the ground as the height of wind speed generator. Output voltage and current of the proposed generator was measured using AD Power HPM-300A and revolutions per minute (RPM)of blade was measured using RPM measurement instrument.

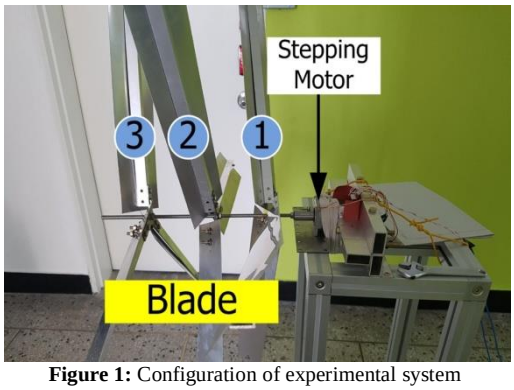

Figure 1: Configuration of experimental system

3. Experimental Results

Figure 2 shows output voltage data graph of the generator according to wind speed. When one-layer blade was applied, output voltage was not measured at wind speed of1m/s~3m/s but output voltage was 2.8V~6.7Vat wind speed of4m/s~10m/s. When two-layer blade was applied, output voltage was not measured at wind speed of1m/s~2m/s and output voltage was2.8V~7.8V when wind speed was 3m/s~10m/s. Finally, when three-layer blade was applied, output voltage was not measured at wind speed of 1m/s~2m/s, and output voltage was 4.1V~9.1V as result of two-layer blade at wind speed of3m/s~10m/s.

Results of output voltage experiment according to blade structure of wind power generator show the wind generator with three-layer blade structure was increased by 36% and 17% than the wind generator with one-layer blade and two-layered blade structure at maximum wind speed 10m/s, respectively.

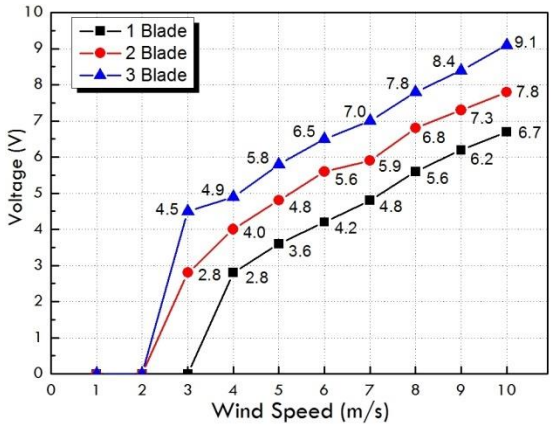

Figure 2: Output voltage of wind power generator according to wind speed

Figure3 shows output current data graph of the generator according to wind speed. When one-layer blade was applied, output current was not measured at wind speed of 1m/s~3m/s and output current of 74mA~137mA was measured at wind speed of 4m/s~10m/s. When two-layer blade was applied, output current was not measured at wind speed 1m/s~2m/s and output current of 82mA~165mA was measured at wind speed of 3m/s~10m/s. Also, when three-layer blade was applied, output current was not measured as result of two-layer blade at wind speed 1m/s~2m/s and output current of 106mA~195mA was measured at wind speed of 3m/s~10m/s.

Results of output current experiment according to blade structure of wind power generator show the wind generator with two-layer blade structure was increased by 42% and 18% than the wind generator with one-layer blade and two-layer blade structure at maximum wind speed 10m/s, respectively.

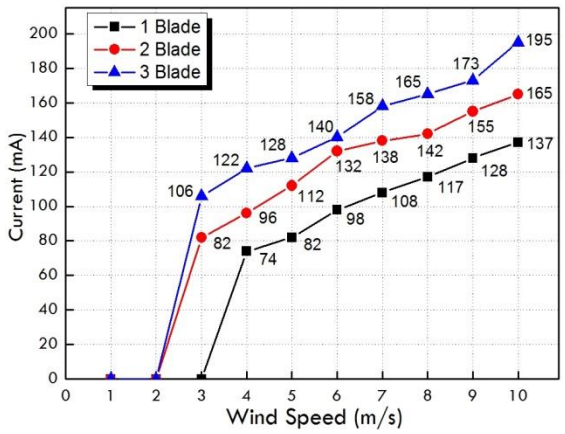

Figure 3: Output current of wind power generator according to wind speed

Figure4 shows RPM data graph of the generator according to wind speed. When one-layer blade is applied, RPM was not measured at wind speed of 1m/s~3m/s and RPM was 110~517 at wind speed of 4m/s~10m/s. When two-layer blade was applied, RPM was not measured at wind speed of 1m/s~2m/s and at wind speed of 3m/s~10m/s, RPM of 185~622 was measured. Also, when three-layer blade was applied, RPM was not measured as result of two-layered blade at wind speed of 1m/s~2m/s and RPM of 225~693 was measured at wind speed of 3m/s~10m/s.

Results of RPM experiment according to blade structure of wind power generator show the wind generator with two-layer blade structure was increased by 34% and 11% than the wind generator with one-layer blade and two-layer blade structure at maximum wind speed 10m/s, respectively.

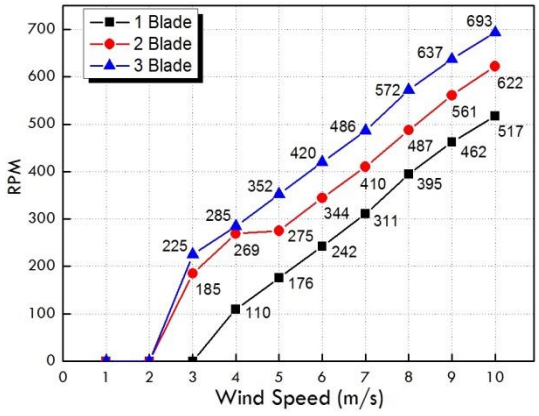

Figure 4: RPM of wind power generator according to wind speed

Figure5 shows electrical power data graph according to wind speed. When one-layer blade was applied, calculation of electrical power is impossible at wind speed of 1m/s~3m/s because output voltage and current was not measured, and electrical power was calculated at 0.21W~0.92W at wind speed of 4m/s~10m/s because output voltage of 2.8V~6.7V and output current of74mA~137mA were measured. When two-layer blade is applied, output voltage and current were not measured at wind speed of 1m/s~2m, output voltage of 2.8V~7.8V and output current of 82mA~165mA were measured and electrical power was calculated at0.23W~1 W at wind speed of 3m/s~10m/s. Also, when three-layer blade was applied, output voltage and current were not measured as result of two-layered blade at wind speed of 1m/s~2m/s, output voltage of 4.5V~9.1V and output current of 106mA~195mA were measured and electrical power was calculated at 0.48W~1.77W at wind speed of 3m/s~10m/s.

The experimental results show that output voltage of the wind generator with three-layer blade structure was increased by 36%

than the wind generator with one-layer blade structure at maximum wind speed 10m/s And output current of the wind generator with three-layer blade structure was increased by 42% and RPM was increased by 34% than the wind generator with one-layer blade structure at maximum wind speed 10m/s. So, Output electrical power of the wind generator with three-layer blade was increased by 93% at maximum wind speed 10m/s.

As a result of experiment, it can be seen that multi-layer blade increase the output of the wind power generator because two and three-layered blade increase the power of unpowered wind power in one-layer blade Also multi-layer blade improves the generation characteristics of wind power generator at low wind speed because it has a well-proportioned and multi-wing structure and works to increase RPM of the wind power generator. Therefore, multi-layer blade structure improves the output characteristics of small wind power generator because it increases utilization of wind power at low wind speed.

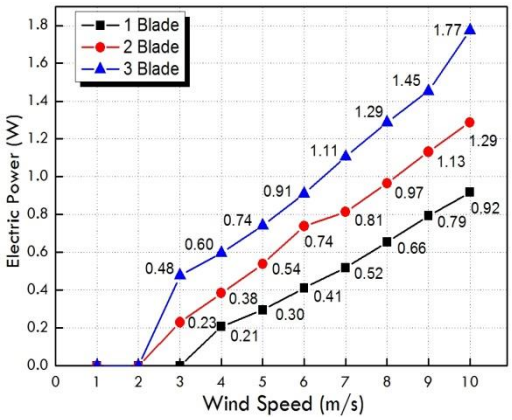

Figure 5:. Output power of wind power generator according to wind speed

4. Conclusion

This paper described output characteristics of small wind power generator with three-layer propeller type blade. In case one-layer blade structure, wind speed must be at least 4m/s for generation of electricity by small wind generator. But two and three-layer blade structures were able to generate electricity at least 3m/s. Also, output voltage, current, RPM and electrical power of the wind generator with three-layered blade structure was increased by 36%, 42%, 34% and93% than the wind generator with one-layer blade structure at maximum wind speed 10m/s, respectively. In other words, using the proposed three-layered blade structure, it is possible to generate electricity at low wind speeds. So, multi-layer blade structure is capable of sufficiently improving output of small wind power generator.

Acknowledgment

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