Power Generation Roof Ventilator

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Abstract. This paper describes about the modified roof ventilator that can generate electricity. The new modification of the roof ventilator system is by adding the extra fins to help it to spin faster and more efficient. Optimum design and performance of the system also discussed. This system is suitable to use for the low speed wind places. The system is containing the combination of the AC generator, roof ventilator, solar charger, batteries and inverter. This system managed to produce 13 Vdc to 14 Vdc to charge the 12 Vdc batteries system. The operational concept of the system is the load will use the energy from the batteries that charged using roof ventilator. The observed performances of system are the voltage and current of the roof ventilator, batteries and the load.

Keywords: roof ventilator, wind energy

1. Introduction

The wind turbine capture the wind’s kinetic energy in a rotor consisting of two or more blades mechanically coupled to a generator. The turbine is mounted on a tall tower to enhance the energy capture. Numerous wind turbines are installed at one site to build a wind produce more energy over the year. Two distinctly configurations are available for turbine design, the horizontal-axis wind turbine (HAWT) configuration (Figure 1) and the vertical-axis wind turbine (VAWT) configuration (Figure 2). The horizontal-axis machine has been the standard in Denmark from the beginning of the wind power industry. Therefore, it is called Danish wind turbine. The vertical-axis machine has the shape of an egg beater and called the Darrieus rotor after its inventor. It has been used in the past because of its specific structural advantage. However, most modern wind turbines use a horizontal-axis design. [1]

The advantages of the HAWT are the blades are to the side of the turbine’s center of gravity, helping stability. It also allows the angle of attack to be remotely adjusted gives greater control, so the turbine collects the maximum amount of wind energy. Tall tower allows access to stronger wind in sites with wind shear and placement on uneven land or in offshore locations and most of them are self-starting. At the same time, it can be cheaper because of higher production volume. The disadvantages are it has difficulties operating near the ground and with turbulent winds because the yaw and blade bearing need smoother, more laminar wind flows. The tall towers and long blades are difficult to transport and need a special installation procedure.

The advantages of the VAWT are the generator, gearbox and other components may be placed on the ground, so the tower doesn’t need to support it, and it is more accessible for maintenance. It also has relatively cost of production, installation and transport compared to horizontal axis turbines. The turbine doesn’t need to be pointed into the wind to be effective. This is an advantage on sites where the wind direction is highly variable. The hilltops, ridgelines and passes can have higher and more powerful winds near the ground than higher up because due to the speed up effect of winds moving up a slope. In these places, vertical axis turbines are suitable. The blades spin at slower speeds than the horizontal turbines,
decreasing the risk of injuring birds. The disadvantages are less efficient than horizontal axis wind turbines. Most of them are only half as efficient as the horizontal ones because of the additional drag that they have as their blades rotate into the wind. The air flow near the ground and other objects can create turbulent flow, which can introduce issues of vibration. This can include noise and bearing wear which may increase the maintenance or shorten the service life [3].

The modified roof ventilator can be recognized as a type of VAWT. It is because it spin vertically when get the kinetic energy from the wind. It also has the same shaft position, blade form and operates in the same basic manner as VAWT [2].

![Horizontal Axis Wind Turbine](image1.png)  ![Vertical Axis Wind Turbine](image2.png)

**Figure 1- Horizontal Axis Wind Turbine**  **Figure 2 - Vertical Axis Wind Turbine**

**2. Potential of wind Energy in Malaysia**

The wind energy in Malaysia which consists of peninsular Malaysia, Sabah and Sarawak is situated in the equatorial area. The organization that manages the data is Malaysian Meteorological Department shows that, the wind over this country is generally light but there still some homogeneous periodic changes in the wind flow patterns. Normally, Malaysia have the four seasons which is, southwest monsoon, northeast monsoon and the other two have the short periods of the intermonsoon seasons. Wind data for the southwest monsoon started in the middle of May until in the end of September with wind speed less than 15 knots. The wind speeds start from 10 to 20 knots during the northeast monsoon. The northwest coast of Sabah and Sarawak region may strengthen to reach 20 knots or more. Researchers’ studies show that Malaysia has a great potential in developing the wind energy system [5].

![Wind map of Malaysia](image3.png)  ![Flow chart](image4.png)

**Figure 3- Wind map of Malaysia**  **Figure 4 – Flow chart**
3. Power generation roof ventilator

Nowadays, the world is talking about the green energy that can save the world from pollutions and green house effects. The main function of the free spinning roof ventilator is to provide fresh air in roof space and living area all year round 24 hours a day free of charge. The additional function of this product is to produce the electrical energy from the roof ventilator that will spin when the wind exist. The new idea of the additional fins is helps to improve the ventilator speed and electrical production. The progress and tests of the system have been fully demonstrated. The consumers not just can enjoy the benefits of the better air ventilation in the house, but also have extra electricity supply for load appliances such as radio, mobile phone charger and aquarium oxygen pump.

The main component of the system is the Auxiliary Current (AC) generator. It will convert the kinetic energy from the wind to the electricity for our usage. The generated electricity then will go through the AD-DC regulator to convert it to Direct Current (DC) voltage. This free electricity has to use the battery charger to allow the charging process running. This to ensure that there will be no back-flow current if the roof ventilator is not functioning. Inverter is use to convert from DC to AC for our AC load usage. The flow chart of the full system of power generation roof ventilator is illustrated in figure 4.

4. Design of power generation roof ventilator

4.1 Wind force

The roof ventilator absorbs the wind energy with their individual blade will move slower that the wind velocity. The different speed generates a drag force to drive the blades. The drag force $F_w$ acting on one blade is calculated as [2]

$$F_w = \frac{C_D A \rho (U_W - U_b)^2}{2}$$  \hspace{1cm} (1)

where $A$ is swept area of the blade; $\rho$ is air density (about 1.225kg/m$^3$ at sea level and at temperature of 15°C); $U_W$ is wind speed; $C_D$ is the drag coefficient (1.9 for rectangular form); and $U_b$ is the speed on the blade surface. It is seen that the wind velocity $U_W$ dominates the wind force as compared to other parameters $A$, $C_D$ and $\rho$. As expected, more driving force $F_w$ is easily and effectively to rotate the turbine and to gain more electricity eventually. The maximum power is obtained while [4]

$$U_b = U_W/3$$  \hspace{1cm} (2)

4.2 Roof ventilator

The top view of the roof ventilator is shown in Figure 5. This is a standard roof ventilator in the market with diameter size, 22 inch. This size has 30 curves blade to capture the wind kinetic energy. Zink is use to produce this roof ventilator because it cannot be effected by rust. The mechanical aspects of this product are just the simple bearing with the proper installation of the components. In this product, research process involved the study how to generate the electricity from the spinning roof ventilator. AC generator is a solution where it manages to meet the objective of the product. The important specification of the generator is the torque must be low to enable it to start at the low speed. The rubber belting is attached to the moving object of the roof ventilator. The AC generator is connected to the belting area by using a small plastic wheel. When the wind blows on the fins and generates enough drag forces, the roof ventilator will rotate [2]. The plastic wheel of the AC generator and the moving roof ventilator will spin synchronously to generate electricity.
4.3 Extra fins

The new invention of the extra fins is to help the roof ventilator to spin faster and more efficient. The extra fins are made from the Zink material to ensure there won’t be any rust in the future. The size of the extra fins is 3inch wide and 20 inch long. Figure 5 shows the actual design of the roof ventilator with extra fins. The experiments start with the quantity of three fins. The result shows that, for the 900 rpm speed, the product can generate about 9.5 Vdc. It manages to produce 13.9 Vdc at the maximum speed of the experiment which is 1200 rpm.

The experiments continue with adding the other fins and total up to four fins. The prediction was, when with more fins, it will spin faster than before. The experiment data shows that, with four fins, the speed of the roof ventilator decrease. It is due to the increasing heavy of the roof ventilator. It just produces 9.2 Vdc at 900 rpm and 12.3 Vdc at the maximum speed of the experiment which is 1200 rpm. The optimum design and quantity of fins is three fins. It manages to produce more than 12Vdc, so that it enables the system to charge the batteries.

5. Conclusion

The power generation roof ventilator manages to generate electricity from the free wind energy. This system also remains the main function which is to provide better air ventilation in the houses or factories. The more wind energy available, the more drag energy to push the fins of the roof ventilator. The extra fins manage to help the roof ventilator to spin faster and the optimum design of this system is by adding the quantity of three extra fins only. The low torque of the AC generator is one of the important factors to make this system perform in the perfect condition. It can produce up to 13.9 Vdc at the 1200 rpm speed. The system manages to charge the 12Vdc batteries system in the good and efficient condition.

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7. References


