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Highway Wind Turbine (Quite Revolution Turbine)

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Abstract

The objective of the project is to design a wind turbine to recapture wind energy from vehicles on the highway. Wind energy is considered the fastest growing clean energy source however; it is limited by variable natural wind. Highways can provide a required considerable amount of wind to drive a turbine due to high vehicle traffic. This energy is unused. Extensive research on wind patterns is required to determine the average velocity of the wind created by oncoming vehicles. The wind turbines will be placed on the medians therefore fluid flow from both sides of the highway will be considered in the design. Using all of the collected data, existing streetlights on the medians can be fitted with these wind turbines. Additionally, since the wind source will fluctuate, a storage system for the power generated will be designed to distribute and maintain a constant source of power. Ideally, the turbine can be used globally as an unlimited power source for streetlights and other public amenities. For this project we are looking for "Vertical Axis Wind Turbine". Mainly Helical type of turbine can be used for this type of application as it collects wind from all kind direction. The price of turbines is increasing in accordance with the rising cost of energy and commodities. The cost of designing the turbine, calculated in energy savings must be recovered in a reasonable time period. Each vehicle on the highway offer an intermittent and uncontrolled source of wind power. The design of the wind turbine must include storage of power and a system to distribute the generated power effectively. Operational noise level and space are other important design considerations. The design of the other parts like Shaft, Flange, Bearings etc is also same important. So review has been made in order to make this project successful.

Keywords: Wind Turbine, Highway, Vehicle, Design.

1. Introduction

Wind energy is the fastest growing source of clean energy worldwide. A major issue with the technology is fluctuation in the source of wind. There is a near constant source of wind power on the highways due to rapidly moving vehicles. The motivation for this project is to contribute to the global trend towards clean energy in a feasible way. Most wind turbines in use today are conventional wind mills with three airfoil shaped blades arraigned around a horizontal axis. These turbines must be turned to face into the wind and in general require significant air velocities to operate. Another style of turbine is one where the blades are positioned vertically or transverse to the axis of rotation. These turbines will always rotate in the same direction regardless of the fluid flow. Due to the independence from the direction of the fluid flow, these turbines have found applications in tidal and surface current flows. To see how effective this sort of turbine would be in air, a helical turbine based on the designs and patents of Dr. Alexander M. Gorlov was chosen. His turbine was developed to improve upon the design of Georges J. M. Darrius by increasing the efficiency and removing pulsating stresses on the blades, caused by the blades hitting their aerodynamic stall in the course of rotation, which often resulted in fatigue failure in the blades or the joints that secured them to the shaft. The turbine takes the Darrius type turbine, which has a plurality of blades arranged transverse to the axis of rotation, and adds a helical twist to their path, insuring that regardless of the position of the turbine, a portion of the blade is always positioned in the position that gives maximum lift. This feature reduces the pulsations that are common in a Darrius type turbine. In his investigations, Gorlov claims that his turbine is significantly more efficient than Darrius' and has achieved overall efficiencies between 30% and 35%. For this investigation, a helical turbine was tested inside and outside a wind tunnel using an electric generator (inside tests only) and a torque meter paired with a tachometer to measure the output power of the turbine and calculate its efficiency. In the end, the turbine did not come close to the claimed 30% efficiency, reaching at best an efficiency of around 0.35%. Further investigations should be made to determine why the results from this investigation were as low as they are.

2. Global Applications:-

The design can be used in any city around the world. It should be environmentally friendly. Labels in various languages and manuals will be provided for each specific city. Figure 1 shows a dramatic increase in the e power increased by nearly 20% in 2012 reaching a new peak of 282 GW. Various sources such as the Global Wind Energy Council show china as a leading country in employment of Wind energy.

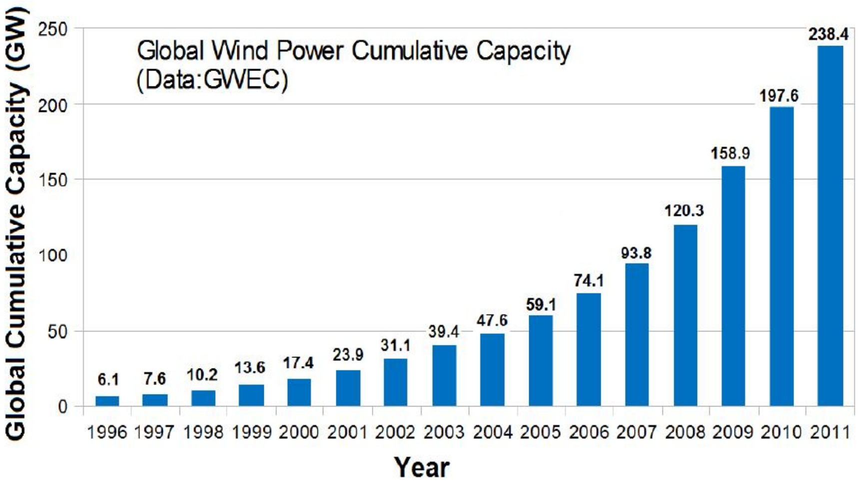


Figure 1: Global trend in wind energy, data from the global wind energy council.

3. Design Challenges:-

The price of turbines is increasing in accordance with the rising cost of energy and commodities. The cost of designing the turbine, calculated in energy savings must be recovered in a reasonable time period. Each vehicle on the highway offers an intermittent and uncontrolled source of wind power. The design of the wind turbine must include storage of power and a system to distribute the generated power effectively. Operational noise level and space are other important design considerations. The wind turbines should have as little negative impact on the placement location as possible.

Wind turbines are traditionally used in remote locations. This offers the additional challenge of having to transport the power generated to the location wherein it will be utilized. Fortunately, the wind turbine in this project is designed for use in high traffic areas where the demand for power is high. Safety is another major design consideration. The turbines must be placed in high traffic areas therefore several safety provisions are incorporated into the design. These safety measures include stationary highway guards surrounding the rotating turbine blades and warning labels.

4. Problem Statement and Solution

A major hindrance in the growth of wind energy is fluctuation in the sources of wind. Highways appear to be a sufficient source of potential wind energy. An in-depth analysis of fluid flow due to traffic on highways must be performed to acquire boundary limits for the wind turbine design. The turbine must be able to store energy for use when there is low traffic, bumper to bumper or stop and go traffic. The design must be sustainable and environmentally friendly. The conventional turbine we use in various applications are mostly Horizontal axis wind turbines. The main problem of these kind of turbines is it can not collect wind from all sides. Another type of wind turbine is Vertical axis wind turbine. Main advantage of this types of turbine is it can collect wind power from all the directions. This advantage of this type of turbine made us to chose this turbines.

4.1 Vertical Axis Wind Turbine:-

There are different types of vertical turbine 1. Savonius 2.Darrieus 3. Giromill 4. Gorlav Helical all turbine from this types have their own advantages and disadvantages because of their constructional features. But all from above the turbines from all kind of prospects helical turbine seems to be fit because of it's better efficiency, higher wind collecting capacity.

4.2 Gorlav Helical Turbine:-

Fig. 2: Gorlav Helical Wind Turbine.

Above Fig shows modified version of Gorlav Helical wind turbine. The design of turbine mainly consist of design of Shaft, Flange, Spoke & Blade etc.

4.2.1 Design of shaft:- The shaft of the turbine consists of a single two foot length of steel measuring 3/8ths of an inch in diameter. The use of steel over a lighter metal such as aluminum was based on the availability of materials on McMaster-Carr where I sourced many of the materials and parts I needed to purchase. The steel rod that was purchased for the shaft had a straightness tolerance of ±0.05 inches where none of the aluminum rods had a tolerance given.

4.2.2 Design of Flange:- The flanges, as shown in Fig 3 are used to attach the spoke arms to the shaft were machined out of aluminum. The primary reason for these flanges being separate pieces instead of being part of the spoke arm was to reduce the amount of material required. The flanges have three bolt holes to attach them to the spoke arm and a single threaded hole for a set screw to secure them along with the spoke arm to the shaft.

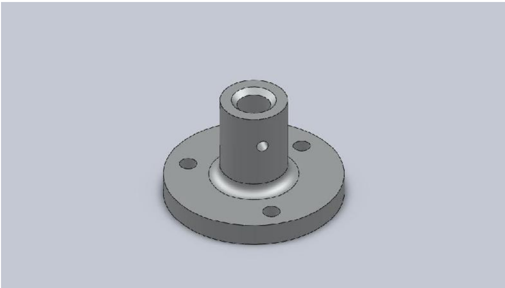


Fig. 3: Showing Flange design

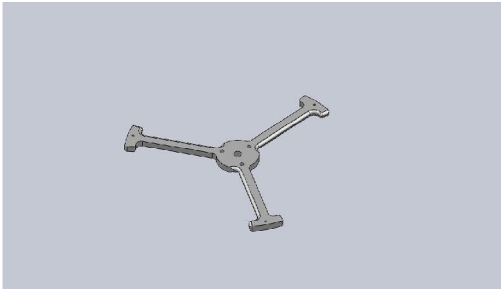
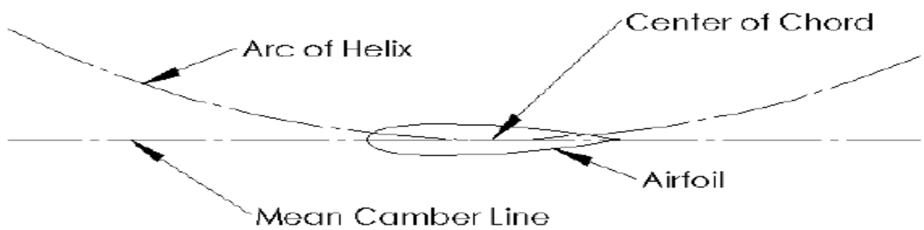


Fig. 4: Showing Spoke design

4.2.3 Design of Spoke:- The spoke arm component, shown in Fig 4, has three arms extending from the central hub of the part with extended sections at the end of the arms to attach the turbine blades. The leading edges of the arms were also rounded to reduce the drag of the arms. For material, ¼ inch polycarbonate was chosen and the parts were machined using a CNC machine.

4.2.4 Design of Blades:- The turbine blades are the most important part of this design. They are 14 inches long and follow a helical path with a 5 inch radius over a 60 degree arc. The cross section is a standard NACA 0018 air foil with a 1.5 inch chord. Since the airfoil is symmetric along the chord, the mean camber line follows the chord. The helical path that the blade follows is drawn along the midpoint of the camber line and the blade is set at a 0 degree angle of attack. The profile of the airfoil is shown in Fig 5



The blades were produced using a 3D printer that built the blades up a layer at a time with ABS plastic. Due to the size constraints of the printer, the blades had to be cut in half and then assembled. The assembly was done with a combination of plastic cement and pins to strengthen the joint. Additionally, the joint was cut in a step shape to increase the surface area for bonding. While the glue and pins created a strong joint, the bending stresses on the blades during operation would be centered on the joint area due to the distance from the supports. The blades were further reinforced with fiber glass sleeves and epoxy, resulting in a stiff blade that showed no visible deformation during testing. Further research still need to on the design of blade to make this project more efficient.

5. Conclusion

Conclusively, extensive data is collected on wind patterns produced by vehicles on both sides of the highway. Using the collected data, a wind turbine is designed to be placed on the medians of the highway. Although one turbine may not provide adequate power generation, a collective of turbines on a long strip of highway has potential to generate a large amount of energy that can be used to power streetlights, other public amenities or even generate profits by selling the power back to the grid. This design concept is meant to be sustainable and environmentally friendly. Additionally, a wind turbine powered by artificial wind has a myriad of applications. Theoretically any moving vehicle can power the turbine such as an amusement park ride. The highway wind turbine can be used to provide power in any city around the globe where there is high vehicle traffic.

6. Acknowledgement

We would like to thank our project guide who is helping us to accomplish our project work as soon as possible.

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