DESIGN AND FABRICATE VERTICAL AXIS WIND TURBINE

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ABSTRACT

We know that there is enough wind globally to satisfy much, or even most, of humanity's energy requirements – if it could be harvested effectively and on a large scale. If the efficiency of a wind turbine is increased, then more power can be generated thus decreasing the need for expensive power generators that cause pollution. Vertical axis wind turbines (VAWTs), which may be as efficient as current horizontal axis systems, might be practical, simpler and significantly cheaper to build maintain than horizontal axis wind turbines (HAWTs).

Keyword: - *wind mill, vawt ,hawt*

INTRODUCTION

If the efficiency of a wind turbine is increased, then more power can be generated thus decreasing the need for expensive power generators that cause pollution. This would also reduce the cost of power for the common people. The wind is literally there for the taking and doesn't cost any money. Power can be generated and stored by a wind turbine with little or no pollution. If the efficiency of the common wind turbine is improved and widespread, the common people can cut back on their power costs immensely.

Ever since the Seventh Century people have been utilizing the wind to make their lives easier. The whole concept of windmills originated in Persia. The Persians originally used the wind to irrigate farm land, crush grain and milling. This is probably where the term windmill came from. Since the widespread use of windmills in Europe, during the Twelfth Century, some areas such as the Netherlands have prospered from creating vast wind farms. The towers without guy wires are called freestanding towers. Something to take into consideration about a tower is that it must support the weight of the windmill along with the weight of the tower.

The first windmills, however, were not very reliable or energy efficient. Only half the sail rotation was utilized. They were usually slow and had a low tip speed ratio but were useful for torque.Since its creation, man has constantly tried to improve the windmill. As a result, over the years, the number of blades on windmills has decreased. Most modern windmills have 5-6 blades while past windmills have had 4~8 blades. Past windmill also had to be manually directed into the wind, while modern windmills can be automatically turned into the wind. The sail design and materials used to create them have also changed over the years.

In most cases the altitude of the rotor is directly proportional to its efficiency. As a matter of fact, a modern wind turbine should be at least twenty feet above and three hundred feet away from an obstruction, though it is even more ideal for it to be thirty feet above and five hundred feet away from any obstruction.Different locations have various wind speeds. Some places, such as the British Isles, have few inhabitants because of high wind speeds, yet they are ideal for wind generation. Did you know that the world's largest wind farm is located in California, and the total wind power generated there exceeds 1,400 megawatts of electricity? (A typical nuclear power plant generates 1,000 megawatts.)geographic features such as mountains also have an influence upon wind. Mountains can create mountain breezes at night, because of the cooler air flowing down the mountain and being heated by the warmer valley air causing a convection current. Valleys are affected in much the same way. In the daytime, the cooler air is above the valleys and the hot air is above the mountains. The hot air above the mountain rises above the valleys and cools, thus creating a convection current in the opposite direction and creating a valley wind. The oceans create convection currents, as well as they mountains or valleys. In the day, the hotter air is above the same and the cooler air is above the ocean. The air heats up over the sand and rises above the ocean and then cools, creating the convection current. At night, the cooler air is above the sand and the warmer air is above the ocean, so the air heats up over the ocean and cools over the sand. As you can clearly see, the time of day also affects the wind.

We know that for windmills to operate there must be wind, but how do they work? Actually there are two types of windmills -- the horizontal axis windmills and the vertical axis windmills. -The horizontal axis windmills have a horizontal rotor much like the classic Dutch four-arm windmill. The horizontal axis windmills primarily rely on lift from the wind. As stated in Bernoulli's Principle, "a fluid will travel from an area of higher pressure to an area of lower pressure." It also states, "as the velocity of a fluid increases, its density decreases." Based upon this principle, horizontal axis windmill blades have been designed much like the wings of an airplane, with a curved top. This design increases the velocity of the air on top of the blade thus decreasing its density and causing the air on the bottom of the blade to go towards the top ...

creating lift. The blades are angled on the axis as to utilize the lift in the rotation. The blades on modern wind turbines are designed for maximum lift and minimal drag.

1.1 BACKGROUND

Vertical axis windmills, such as the Savonius (built in 1930) use drag instead of lift. Drag is resistance to the wind, like a brick wall. The blades on vertical axis windmills are designed to give resistance to the wind and are as a result pushed by the wind. Windmills, both vertical and horizontal axis, have many uses. Some of them are: hydraulic pump, motor, air pump, oil pump, churning, creating friction, heat director, electric generator, Freon pump, and can also be used as a centrifugal pump.

There are many types of windmills, such as: the tower mill, sock mill, sail windmill, water pump, spring mill, multi-blade, Darrieus, savonis, cyclo-turbine, and the classic four-arm windmill. All of the above windmills have their advantages. Some windmills, like the sail windmill, are relatively slow moving, have a low tip speed ratio and are not very energy efficient compared to the cyclo-turbine, but are much cheaper and money is the great equalizer. been many improvements to the windmill over the years. Windmills have been equipped with air breaks, to control speed in strong winds. Some vertical axis windmills have even been equipped with hinged blades to avoid the stresses at high wind speeds. Some windmills, like the cyclo-turbine, have been equipped with a vane that senses wind direction and causes the rotor to rotate into the wind. Wind turbine generators have been equipped with gearboxes to control [shaft] speeds. However, Europeans had been experimenting with curved blades on vertical wind turbines for many decades before this. Wind turbines have also been equipped with generators which convert shaft power into electrical power. Many of the sails on windmills have also been replaced with propeller-like airfoils. Some windmills can also stall in the wind to control wind speed. But above all of these improvements, the most important improvement to the windmill was made in 1745 when the fantail was invented. The fantail automatically rotates the sails into the wind.

Most wind turbines start to generate power at 11 m/s and shut down at speeds near 32m/s. Another variable of the windmill's efficiency is its swept area. The swept area of a disk--shaped wind wheel is calculated as: Area equals pi times diameter squared divided by four (pi equals 3.14).

Another variable in the productivity of a windmill is the wind speed. The wind speed is measured by an anemometer. Savonius and other vertical-axis machines are good at pumping water and other high torque, low rpm applications and are not usually connected to electric power grids.Another necessity for a windmill is the tower. There are many types of towers. Some towers have guy wire to support them and others don't. The towers without guy wires are called freestanding towers. Something to take into consideration about a tower is that it must support the weight of the windmill along with the weight of the tower. Towers are also subject to drag.

Scientists estimate that, by the 21st Century, ten percent of the world's electricity will come from windmills.

1.2 SAVONIUS WIND TURBINE

Savonius wind turbines are a type of vertical-axis wind turbine (VAWT), used for converting the force of the wind into torque on a rotating shaft. The turbine consists of a number of aerofoils, usually—but not always—vertically mounted on a rotating shaft or framework, either ground stationed or tethered in airborne systems.

The Savonius wind turbine was invented by the Finnish engineer Sigurd Johannes Savonius in 1922. However, Europeans had been experimenting with curved blades on vertical wind turbines for many decades before this. The earliest mention is by the Italian Bishop of Czanad, who was also an engineer. He wrote in his 1616 book Machinae novae about several vertical axis wind turbines with curved or V-shaped blades. None of his or any other earlier examples reached the state of development made by Savonius. In his Finnish biography there is mention of his intention to develop a turbine-type similar to the Flettner-type, but autorotationary. He experimented with his rotor on small rowing vessels on lakes in his country. The Savonius turbine is one of the simplest turbines.

Savonius turbines are used whenever cost or reliability is much more important than efficiency. Most anemometers are Savonius turbines for this reason, as efficiency is irrelevant to the application of measuring wind speed. Much larger Savonius turbines have been used to generate electric power on deep-water buoys, which need small amounts of power and get very little maintenance. Design is simplified because, unlike with horizontal axis wind turbines (HAWTs), no pointing mechanism is required to allow for shifting wind direction and the turbine is self-starting. Savonius and other vertical-axis machines are good at pumping water and other high torque, low rpm applications and are not usually connected to electric power grids. They can sometimes have long helical scoops, to give smooth torque.The most ubiquitous application of the Savonius wind turbine is the Flettner Ventilator, which is commonly seen on the roofs of vans and buses and is used as a cooling device. The ventilator was developed by the German aircraft engineer Anton Flettner in the 1920s. It uses the Savonius wind turbine to drive an extractor fan. The vents are still manufactured in the UK by Flettner Ventilator Limited.Small Savonius wind turbines are sometimes seen used as advertising signs where the rotation helps to similarly-sized lift-type turbines. Much of the swept area of a Savonius rotor may be near the ground, if it has a small mount without an extended post, making the overall energy extraction less effective due to the lower wind speeds found at lower heights.

1.3 CHARACTERISTICS OF VAWT

Wind Speed

This is very important to the productivity of a windmill. The wind turbine only generates power with the wind. The wind rotates the axis (horizontal or vertical) and causes the shaft on the generator to sweep past the magnetic coils creating an electric current.

Blade Length

This is important because the length of the blade is directly proportional to the swept area. Larger blades have a greater swept area and thus catch more wind with each revolution. Because of this, they may also have more torque.

Base Height

The height of the base affects the windmill immensely. The higher a windmill is, the more productive it will be due to the fact that as the altitude increases so does the winds speed.

Base Design

Some base is stronger than others. Base is important in the construction of the windmill because not only do they have to support the windmill, but they must also be subject to their own weight and the drag of the wind. If a weak tower is subject to these elements, then it will surely collapse. Therefore, the base must be identical so as to insure a fair comparison.

It is evident, because of the cubic dependence on wind velocity that small increases in V markedly affect the power in the wind

e.g. doubling V, increases P_w by a factor of 8.

Availability of wind V curve at the proposed site(t)

This important curve determines the maximum energy in the wind and hence is the principle initially controlling factor in predicting the electrical o/p and hence revenue return of the WECS machines, it is desirable to have average wind speed V such that

V≥12-16 km/hr i.e. (3.5 – 4.5 m/sec).

Wind structures at the proposed site

draw attention to the item advertised. They sometimes feature a simple two-frame animation.

1.4 PRINCIPLE OPERATION

Aerodynamically, it is a drag-type device, consisting of two or three scoops. Looking down on the rotor from above, a two-scoop machine would look like an "S" shape in cross section. . Because of the curvature, the scoops experience less drag when moving against the wind than when moving with the wind. The differential drag causes the Savonius turbine to spin. Because they are drag-type devices.

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