DESIGN AND IMPLEMENTATION OF VEHICLE WIND TURBINE

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ABSTRACT

This research targets the design of a wind turbine that will be fitted in the electric car to generate electrical power to charge the car batteries when in motion. A portable horizontal axis diffuser augmented wind turbine is adopted for the design since that is able to produce a higher power output as compared to the conventional bare type wind turbine. The air current is generated by the car when it begins to move. Through the theoretical calculation on the power generated from the wind, a significant amount of electrical power (about 3.26 kW) is restored to the batteries when the car is moving at a speed of 120 km/h.

Keywords: Power,Wind Turbine, Mechanical System, Generator.

INTRODUCTION

Power has been extracted from the wind over hundreds of years with historic designs, known as windmills, constructed from wood, cloth and stone for the purpose of pumping water or grinding corn.Historic designs, typically large, heavy and inefficient, were replaced in the 19th century by fossil fuel engines and the implementation of a nationally distributed power network.

A greater understanding of aerodynamics and advances in materials, particularly polymers, has led to the return of wind energy extraction in the latter half of the 20th century. Wind power devices are now used to produce electricity, and commonly termed wind turbines. The HAWT has therefore emerged as the dominant design configuration, capitalised by all of today's leading large scale turbine manufacturers.

LITERATURE REVIEW

A wind turbine is a device that converts kinetic energy from the wind into mechanical energy. If the mechanical energy is used to drive machinery, such as for grinding grain or pumping water, the device is called a windmill or wind pump[1]. The smallest turbines are used for applications such as battery charging or auxiliary power on sailing boats, while large grid-connected turbines are becoming large sources of commercial electric power[2].Wind turbines can be put into two basic categories: namely, vertical axis and horizontal axis wind turbines. part is what converts the turning motion of a wind turbine's blades into electricity. Inside this component, coils of wire are rotated in a magnetic field to produce electricity [3].Different generator designs produce either alternating current (AC) or direct current (DC), and they are available in a large range of output power ratings. If mechanical energy is converted into electrical energy that device is generator..The generator's rating, or size, is dependent on the length of the wind turbine's blades because more energy is captured by longer blades[5].On account of the relatively large thrust (axial) and radial loads in the main shaft and the high speed involved, the spherical roller bearing is often used, see Fig. 19.Spherical roller bearings have two rollers with acommon sphere raceway in the outer ring. The two inner ring raceways are inclined at an angel to the bearing axis[8].

METHODOLOGY

Systems Materials/Components/Flowchart/Block Diagram/Theory

The main components of the proposed design are the rotor, main shaft, main bearing coupling, generator, inlet safety guard, exhaust safety guard. The rotor is coupled to the main shaft by a set of four hexagonal head bolts. The main shaft and the generator are fastened to the supports on the base.

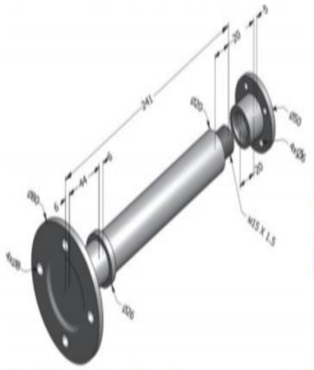


Fig. 17 Main Shaft with Coupling

Fig. 18 Alternator

Synthesis/Algorithm/Design/Method

Through research and calculations, this project determined how the different alternatives to the design components affected the overall design of the turbine and is discussed in the subsequent sections. The following three sections were outlined: the tower design, foundation design, and the project analysis.

Each section was researched individually and eventually was compared with the other two sections. The individual design sheets for the tower design, foundation design, and project analysis were developed individually throughout the course of this project. When the design sheets were finalized, they were linked together in order to create one completely integrated spreadsheet which produced output sheets that summarized important information regarding Energy Output, Financial Analysis, Foundation Design, and Tower Design. With little knowledge about the specific calculations, a user can use this spreadsheet simply by inputting common information outlined in a user friendly main page and check if their wind turbine project is feasible.

Characterizations

The method of propulsion critically affects the maximum achievable efficiency of the rotor. Historically, the most commonly utilised method was drag, by utilising a sail faced normal to the wind, relying on the drag factor (Cd) to produce a force in the direction of the prevailing wind. This method proved inefficient as the force and rotation of the sail correspond to the wind direction; therefore, the relative velocity of the wind is reduced as rotor speed increases .

Power Production

A. The kinetic energy of wind :

The kinetic energy of the wind is the source of the driving force of a wind turbine.

That kinetic energy can be depicted by the formula

E = f. mspec .v3

In this formula:

E = the kinetic energy

mspec =the specific mass (weight) of air

v = the velocity of the moving air (the wind)

f = a calculating factor without any physic meaning

The power in the wind is proportional to:

1) The Area of Windmill Being Swept by the Wind

2) The Cube of the Wind Speed

3) The Air Density - Which Varies With Altitude.

The formula used for calculating the power in the wind is shown below:

Power = (density of air x swept area x velocity cubed)/2

P = ½. ρ(A)(V)3

Where,

P is power in watts (W)

ρ is the air density in kilograms per cubic metre (kg/m3)

A is the swept rotor area in square metres (m2) & V is the wind speed in metres per second (m/s).

Results and Discussions

For reasons of efficiency, control, noise and aesthetics the modern wind turbine market is dominated by the horizontally mounted three blade design, with the use of yaw and pitch, for its ability to survive and operate under varying wind conditions. An international supply chain has evolved around this design, which is now the industry leader and will remain so for the immediate foreseeable future. During the evolution of this design many alternatives have been explored and have eventually declined in popularity. Manufacturers seeking greater cost efficiency have exploited the ability to scale the design, with the latest models reaching 164 m in diameter. The scale of investment creating alternative designs of comparative size now ensures that new challengers to the current configuration are unlikely.

The results in this work are collected through practical road test. Four cases depicted in table are considered for this experiment. From table it is clear that for case 1, 2 and 3, the power is insufficient to mention as either vehicle is stopped or air speed is too low. However, for case 4, both vehicle and air speed are in functioning mode. Hence, case 4 is the active case for this project. Therefore, for the experimental setup and data

collection, case 4 is considered only.

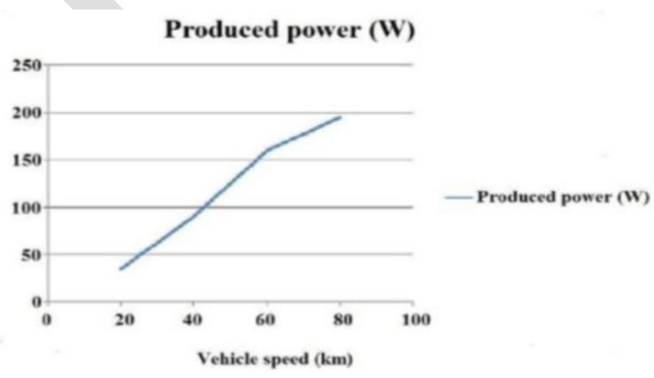
Table – Vehicle speed and power

Cases	Vehicle	Wind Speed	Power Status	Mode
Case 1	Stopped	≈ 0	≈0 (Negligible power)	Inactive
Case 2	Stopped	≠ 0	P (Negligible power)	Inactive
Case 3	Moving	≈ 0	P (Negligible power)	Inactive
Case 4	Moving	≠ 0	P (Maximum power)	Active

Results are recorded based on four considerations to measure, rotation of turbine, vehicle speed, produced torque & wind force and generated power.

Torque and wind force depend on vehicle speed in

principle. Higher vehicle speed produce high torque due to increased wind force which conclude increased



Produced power (w) vs. vehicle speed.

power. From figure it is evident that, produced power increases with vehicle speed.

Helpful hints

Most of the vehicle whether commercial or private run through the residential area and public way, so a VWT will be very closer to public exposure and be a sensitive issue for public safety. Usually for commercial WT system the total area is a restricted area for unauthorized person, however it is not possible for the VWT. It is recommended to add a protecting case for the WT, it will increase the strength and protection. The case should cover the back side of the WT and should be opened in front side for the incoming wind. Technically, the case should be styled as mesh so that it can possess a lot of gaps to release the deflected air and stabilize the system from falling down. Moreover, sometimes sudden gust can come through the way. Hence, to control this situation an emergency manual break should be attached with the vehicle.

LIMITATIONS

Since this project is made for electric vehicles it is not possible for implementing it on fast vehicles like train, aeroplanes, etc. Also it will be difficult to implement in fast cars since there are not air compressors which can cause wearing and tearing of the metal which will be bombarded with high speed wind.

FUTURE SCOPE

A method for generating electricity using high wind pressure generated by fast moving vehicles channeling the induced wind in the direction of the wind turbine. A fast moving vehicle compresses the air in the front of it and pushes the air from its sides thereby creating a vacuum at its rear and its sides as it moves forward.

The kinetic energy of the wind movement thus created can be used to generate electricity. The moving vehicles encounters wind may be railway trains or airplanes, will sweep off it, in a faster manner making heavy winds. During this, when a wind turbine, if fit to the moving vehicle will generate adequate amount of energy. The air flow will cause turbine to rotate and thus electricity can be produced.

CONCLUSION

This value is normally defined by the turbine designers but it is important to understand the relationship between all of these factors and to use this equation to calculate the power at wind speeds other than the rated wind speed

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