Determination of Energy Produced By Wind Mill on Running Vehicle

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Abstract

The negative effects of non-renewable fossil fuels have forced scientists to draw attention to clean energy sources which are both environmentally more suitable and renewable. By using the wind energy, power may be produced. The project entitled "Energy Produced by using the Wind Energy" is aimed to produce power with renewable source of energy like wind. In this project by using a small fan blade, electric power is produced by utilizing the drag force of the wind in a moving vehicle. This project aims to design a model for using wind energy to generate electricity which in turn may be used to run electrical utilities directly or through a storage battery

Keywords – Drag ,Wind

1. Introduction

The negative effects of fossil fuels which are non-renewablehave forced the scientists to draw attention to clean energy sources that are both environmentally more suitable and renewable. One of these sources is wind energy. Global wind energy market among other renewable sources has been experiencing a rapid growth especially during the last two decades. Wind is a fuel-free, inexhaustible energy source and does not cause pollution in electricity production. Moreover, as wind energy can generate power near load centers, it eliminates the transmission loss in the lines through rural and urban landscapes. Today, wind energy is widely used to produce electricity in many countries in America, Asia and especially Europe. According to 2008 data from European Wind Energy Association (EWEA), total installed wind power capacity in the world reached 94,122MW by an increase of 27% compared to the year 2006 [1]The use of wind turbines to generate electricity can be traced back to the late 19th century with windmill generator constructed in the USA [2].According to 2008 data from The Electricity Market Regulatory Authority (EMRA), it can be seen that Turkey is rather unsuccessful

2. Working principle of wind turbine.

The unit producing the power from wind is known as a wind turbine. Wind turbine (Rotor) mounted on a main shaft collects the kinetic energy from wind. With the help of gearbox the speed is raised on the other hand it is fed to the electric generator shaft. The electric generator converts this mechanical energy into electrical energy. Our project working principle is same as like that, it is water lifted by pump which is operated by wind turbine.

2.1 Betz's Law

Betz' law was first formulated by the German Physicist Albert Betz in 1919.

Betz' law says that you are limited to a maximum conversion of 16/27 (or 59%) of the kinetic energy in the wind to mechanical energy using a wind turbine.

2.2 Betz's Limit

Theoretical maximum energy extraction from wind = 16/27 = 59.3%

Undisturbed wind velocity reduced by 1/3

3. Applications of Wind Energy

3.1 Energy-generating wind turbines:

Wind turbines are installed to capture the power of the wind and be able to convert it to energy. This can be on a broad scale, such as the wind turbines found on wind farms or can be on a smaller scale, such as individual wind turbines people use to generate power for their home. Companies even want to take advantage of the wind

3.2 Wind-powered vehicles:

You've probably heard about this one recently. A car, powered primarily by wind (using kites), just completed a 3,100 mile journey across Australia. While it wasn't 100% powered by the wind, it was a good example of how cars can also be powered using alternative energies. It used a combination of wind, kite and batteries. In total, it reportedly used about $10-$15 of energy for the entire 3,100 mile journey.

3.3 Wind/Kite-Powered Cargo Ships:

Another great example of tapping into the power of the wind can be found with Cargill company. Cargill has stepped up and gone with the innovative idea of installing a large kite on one of its cargo ships in order to tap into the power of the wind and thus reduce fuel consumption and CO2 emissions. Now, of course wind has been used for hundreds and thousands of year to "power" sailing and smaller vessels, but now it is being used to help power larger cargo ships as well.

3.4 Wind-Powered Sports:

For many, many years the wind has been used to power our love of sports, both literally and figuratively. Everything from simple kite-flying to sailing, wind-surfing, kite-surfing, hang-gliding, para-sailing, wind-skiing and more.

3.5 Wind-Powered Water Pumps:

Using the wind to help pump water out of the ground is not something new. It is however a very helpful and sometimes much needed tool when it comes to some communities and countries. Tapping into the power of the wind makes sense, esp when it comes to the work needed to pump water

3. Experimental Methodology

The main objective of our project is to convert wind energy into electric energy. By installing this device as shown in figure we can run audio system, mobile charging application, etc. To run any electric system, electric power from a battery or engine power is essential, so by installing this device, we can save the engine power which can be further utilized to run the vehicle which also leads to saving of fuel and/or in turn charge the battery.

As shown in Figure, the drag and thrust force acts on a moving vehicle. The drag force can be used for useful electrical energy generation which in turn may either be stored in a battery or used to run a electrical utility. Fig. 3.2 shows the detailed drawing of a wind energy convertor system converting the drag force of wind into useful electrical power. Fig. 3.3 shows the details of the structure of the support system for the wind energy generator

Fig 3.1 Model of Wind Energy Convertor

5. Design & Calculations

5.1 Drag Force

In fluid dynamics, drag (sometimes called air resistance or fluid resistance) refers to forces that oppose the relative motion of an object through a fluid (a liquid or gas).

Drag forces act in a direction opposite to the oncoming flow velocity. Unlike other resistive forces such as dry friction, which is nearly independent of velocity, drag forces depend on velocity.

For a solid object moving through a fluid, the drag is the component of the net aerodynamic or hydrodynamic force acting opposite to the direction of the movement

5.2 Equation of Drag Force:

The drag equation calculates the force experienced by an object moving through a fluid at relatively large velocity (i.e. high Reynolds number, Re > ~1000), also called quadratic drag. The equation is attributed to Lord Rayleigh, who originally used L2 in place of A (L being some length).

5.2.1 The force on a moving object:

$\mathbf{P_d = F_d \times V.}$

The power required to overcome the aerodynamic drag

Calculation

At S.T.P Condition,

I = 0.05 Amp.

Fan Diameter = 310 mm.

Velocity (Vi) = 25 km/hr.

$$= \frac{1 \times 10^5}{287 \times (25 + 273)}$$

$$= 1.2 \text{ kg/m}^3$$

Axial Force= $\frac{\pi}{9} \times \rho \times D^2 \times Vi^2$

$$= \frac{\pi}{9} \times 1.2 \times (0.31)^2 \times \left(\frac{25\times1000}{3600}\right)^2$$

$= 1.94$ N

Power in Wind$= \frac{1}{2} \times \rho \times A \times Vi^3$

$$= \frac{1}{2} \times 1.2 \times \frac{\pi}{4} \times (0.310)^2 \times \left(\frac{25\times1000}{3600}\right)^2$$

$=$15.16 watt.

Circumferential Force $= \frac{\square\times\rho\times D\times Vi^3}{8\ N}$

$$= \frac{0.3 \times 1.2 \times 0.310 \times 60}{8 \times 720}\left(\frac{25 \times 1000}{3600}\right)^3$$

$= 0.388$ N.

Power$= V \times I$

$= 12 \times 0.05$

$= 0.6$ Watt.

At S.T.P Condition,

I = 0.1 Amp.

Fan Diameter= 310 mm.

Velocity (Vi) = 30 km/hr.

$$= \frac{1 \times 10^5}{287 \times (25 + 273)}$$

$= 1.2$ kg/m^3

Axial Force$= \frac{\pi}{9} \times \rho \times D^2 \times Vi^2$

$$= \frac{\pi}{9} \times 1.2 \times (0.31)^2 \times \left(\frac{30\times1000}{3600}\right)^2$$

$= 2.79$ N

Power in Wind$= \frac{1}{2} \times \rho \times A \times Vi^3$

$$= \frac{1}{2} \times 1.2 \times \frac{\pi}{4} \times (0.310)^2 \times \left(\frac{30 \times 1000}{3600}\right)^3$$

$=$26.2 watt.

Circumferential Force $= \frac{\square\times\rho\times D\times Vi^3}{8\ N}$

$$= \frac{0.3 \times 1.2 \times 0.310 \times 60}{8 \times 1100}\left(\frac{30 \times 1000}{3600}\right)^3$$

$= 0.44$ N.

Power $= V \times I$

$= 12 \times 0.1$

$= 1.2$ Watt.

At S.T.P Condition,

I = 0.2 Amp.

Fan Diameter= 310 mm.

Velocity (Vi) = 35 km/hr.

$$= \frac{1 \times 10^5}{287 \times (25 + 273)}$$

$= 1.2$ kg/m^3

Axial Force $= \frac{\pi}{9} \times \rho \times D^2 \times Vi^2$

$$= \frac{\pi}{9} \times 1.2 \times (0.31)^2 \times \left(\frac{35\times1000}{3600}\right)^2$$

$= 3.80$ N

Power in Wind $= \frac{1}{2} \times \rho \times A \times Vi^3$

$$= \frac{1}{2} \times 1.2 \times \frac{\pi}{4} \times (0.310)^2 \times \left(\frac{35 \times 1000}{3600}\right)^3$$

$= 41.59$ Watt

Circumferential Force $= \frac{\square\times\rho\times D\times Vi^3}{8\ N}$

$$= \frac{0.3 \times 1.2 \times 0.310 \times 60}{8 \times 1600}\left(\frac{35 \times 1000}{3600}\right)^3$$

$= 0.48$ N

Power $= V \times I$

$= 12 \times 0.2$

$= 2.4$ Watt.

At S.T.P Condition,

$P = 1 \times 10^5$ Pa

R = 287 J/KgK

T= 25°C

I = 0.3 Amp.

Fan Diameter= 310 mm.

Velocity (Vi) = 40 km/hr.

$$= \frac{1 \times 10^5}{287 \times (25 + 273)}$$

$= 1.2$ kg/m^3

Axial Force $= \frac{\pi}{9} \times \rho \times D^2 \times Vi^2$ =

$$\frac{\pi}{9} \times 1.2 \times (0.31)^2 \times \left(\frac{40 \times 1000}{3600}\right)^2$$

= 4.96 N

Power in Wind $= \frac{1}{2} \times \rho \times A \times Vi^3$

$$= \frac{1}{2} \times 1.2 \times \frac{\pi}{4} \times (0.310)^2 \times \left(\frac{40 \times 1000}{3600}\right)^3$$

= 62.09 Watt

Circumferential Force $= \frac{\square \times \rho \times D \times Vi^3}{8\ N}$

$$= \frac{0.3 \times 1.2 \times 0.310 \times 60}{8 \times 2100}\left(\frac{40 \times 1000}{3600}\right)^3$$

= 0.55 N

Power = V × I

= 12 × 0.3

= 3.6 Watt.

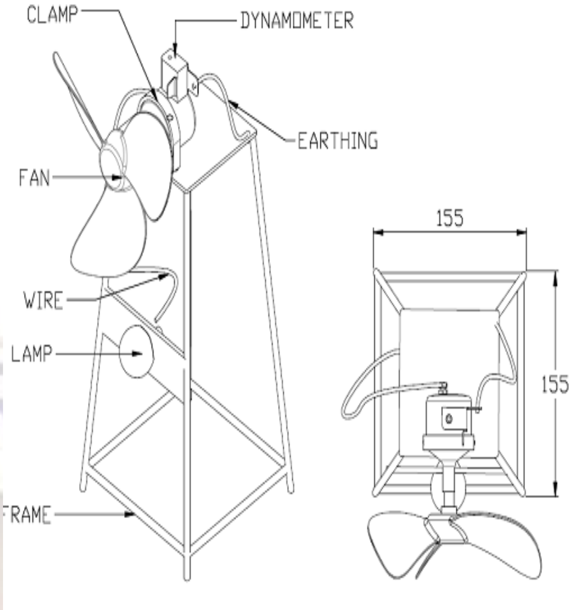


Fig 5.1 Detailed drawing of the wind energy convertor

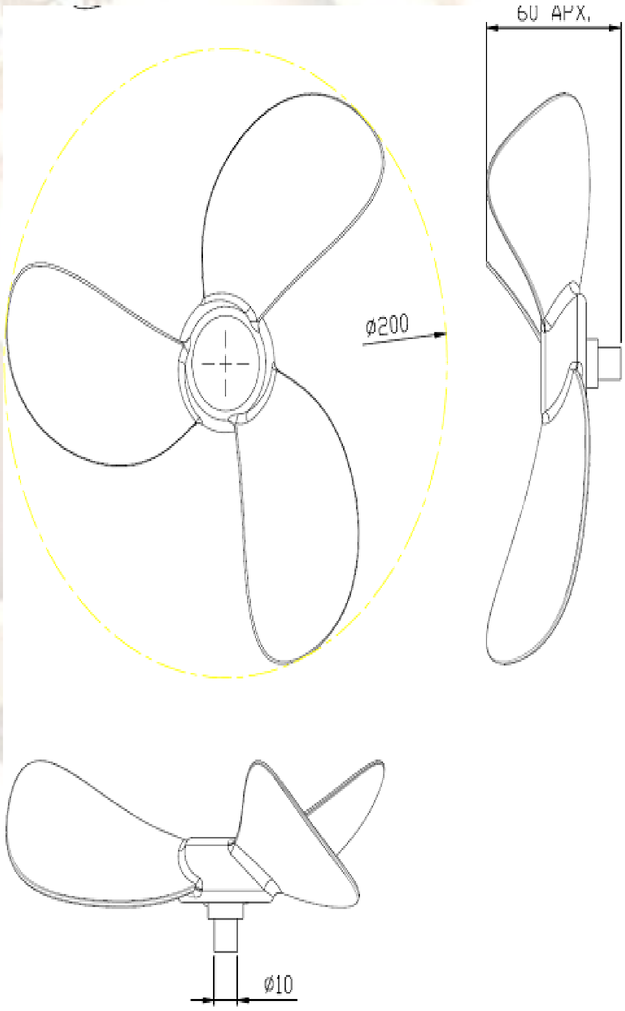
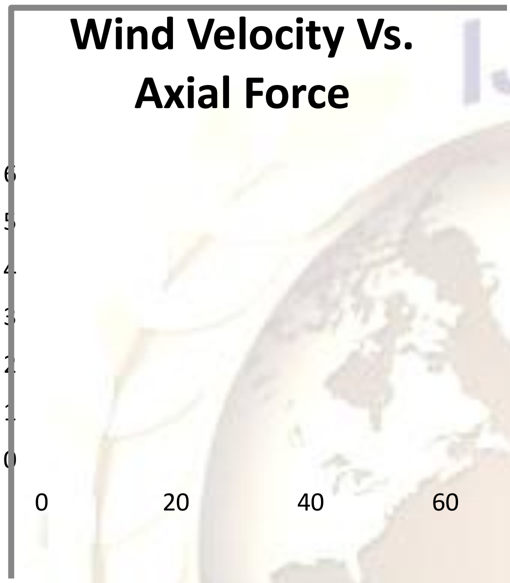


Fig 5.2 Details of the fan

6. Result and Conclusion

Velocity (km/hr)	Axial Force (N)	Circumferential Force (N)	Power in Wind (Watt)	Power Developed (Watt)	ηmax (%)
25	1.94	0.38	15.16	0.6	3.95
30	2.79	0.44	26.2	1.2	4.58
35	3.80	0.48	41.59	2.4	5.77
40	4.96	0.55	62.09	3.6	5.79



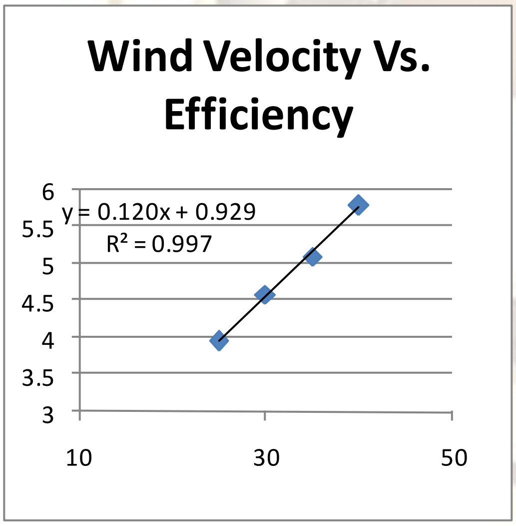


Fig 6.1 Wind Velocity Vs Axial force,Efficiency

Wind energy is a renewable energy available abundantly and can be used for electric power generation. The mechanical and electric energy produced by wind energy using wind turbine may be used in a moving vehicle for various electrical utilities.

A simple prototype fan installed in a vehicle is used to run a dynamo to generate electrical power. From the experiment we can conclude that if the velocity of the wind increases, the overall efficiency increases. As the wind energy is a renewable source of energy so we can save some amount of fuel. Using more such wind energy convertors in a moving vehicle we can save precious fuel by using the wind power to run the utilities.

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