ONBOARD CHARGING SYSTEM FOR ELECTRIC VEHICLE

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Abstract: *This project explores the use of a wind turbine that can be mounted on top of an electric car or inside the grille of the vehicle to generate electric power to charge the batteries while the vehicle is in motion. The turbine is positioned inside the grille of the car or at the top where the flow of wind is highest due to the aerodynamic nature of the car. This setup is compact and can be placed in either of the preferred part of the car. The apparatus will generate power from the wind coming in through the grill of the vehicle. It will then be transferred to the battery via connection cables where the power will be stored. The battery will then transfer the power created by the wind turbine to the engine as the current electric engines transfer electricity. The turbine will make a surplus of electric energy; so much as the vehicle will not need to be plugged in to charge for a good time period. This machine will have a blade that turns as a windmill turns, generating power in a similar way. This setup has a frame to accommodate parts for making the turbine and serves as a support. The current is generated when the car is in motion. From the calculations a significant amount of power is restored to the batteries when the car is in motion. This charge can be then used in operation of electrical equipment of the car. It is impossible to regenerate whole amount of the lost energy due to losses in the system, but a part of the energy can be regained. This setup works more efficiently while moving downhill where there is no need of external power.*

Keywords; battery, turbine, electrical vehicle, wind power, charging

Introduction

The electric vehicle has been around for over 100 years, and it has an interesting history of development that continues to the present. France and England were the first nations to develop the electric vehicle in the late 1800s. It was not until 1895 that Americans began to devote attention to electric vehicles. Many innovations followed and interest in motor vehicles increased greatly in the late 1890s and early 1900s. Since the invention of electric car, it has been developed till date. Despite this fact, the major challenge which is their short driving range still exists.

Major Components in an Electric Car or Electric vehicle is made up of three main parts; namely, the motor, the controller and the battery.

Electric motor

It is the most important part of the vehicle; it is the part responsible for the propelling of the car. There are three different types of electric motors; these include, DC wound, Permanent magnet DC and AC motor. The number two major component of electric car parts is the battery. While some cars would use the standard car batteries as a source of energy, the more advanced ones use the Li-ion batteries as more efficient energy source that gives extra range of operation for the vehicle. They require less time to be charged and provide more energy for the motor attached Controller the third part of the electric car parts is the controller this part. Is responsible for power management; it senses the amount of energy needed by the motor and supplies it directly from the batteries in order to get the car moving. The controller is very important because it synchronizes the operation of both the motor and the battery

Charging of an electric car can take up to 6 – 8 hours.

Fig.1- The alternator inside the turbine

Figure shows the alternator setup embedded with the tunnel in turbine setup. This alternator is attached to the either side of the tunnel as to not disturb the integrity of the turbine and as the alternator is quite heavy in this case it cannot be place without support inside, so it has been welded.

Air distribution in a moving car

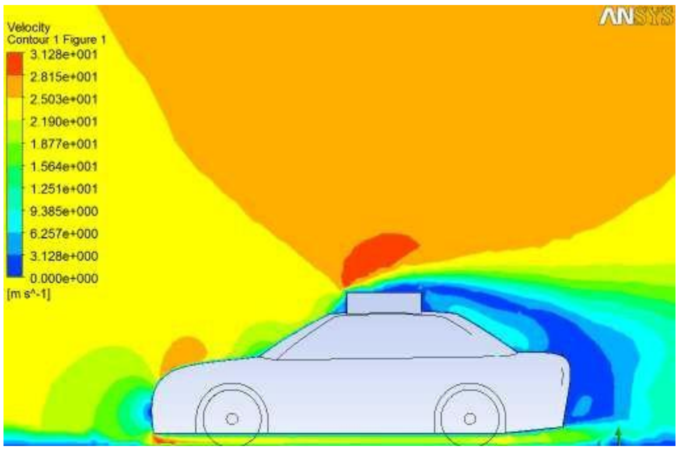

Fig.2-Simulation of air movement in a moving car

The image shows a simulation of sedan car in motion, which reveals that the velocity distribution of air around a moving car is highest at the top of the roof. This helps to position the turbine at the point where the highest power can be extracted.

WIND TURBINES

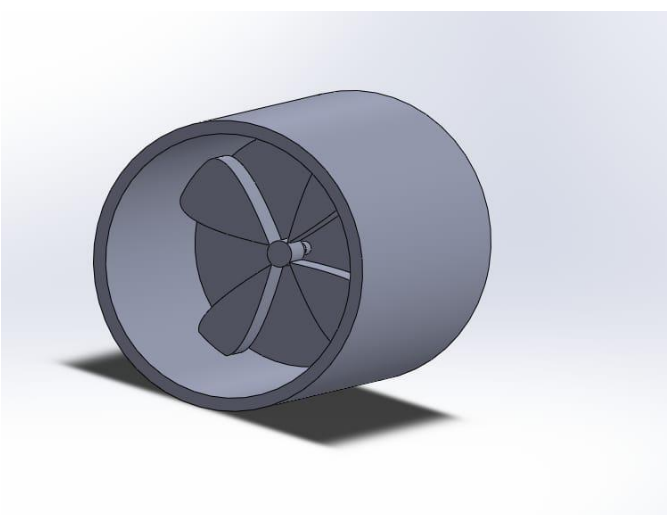

Fig.3- A basic wind turbine model

A wind turbine is a device that converts kinetic energy from the wind into mechanical energy. If the mechanical energy is used to produce electricity, the device is called a wind generator. 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. 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. Wind turbines can be put into two basic categories: namely, vertical axis and horizontal axis wind turbines.

Vertical Axis Wind Turbine,

The vertical axis wind turbine has its blades rotating on an axis perpendicular to the ground

Horizontal Axis Wind Turbine,

The horizontal axis machine has its blades rotating on an axis parallel to the ground. This type of turbine has the main rotor shaft and electrical generator at the top of a tower and must be pointed into the wind. Small turbines are pointed by a simple wind vane, whiles large turbines generally use a wind sensor coupled with a servo motor.

Main Parts of a Wind Turbine

There are three major components that made up a wind turbine. These include, the rotor, the generator and the tower.

Rotor

The portion of the wind turbine that collects energy from the wind is called the rotor. The rotor usually consists of two or more metal blades which rotate about an axis (horizontal or vertical) at a rate determined by the wind speed and the shape of the blades. The blades are attached to the hub, which in turn is attached to the main shaft.

Generator

This 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. Different generator designs produce either alternating current (AC) or direct current (DC), and they are available in a large range of output power ratings. 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.

Tunnel,

The tunnel on which a wind turbine is mounted is not just a support structure. It also raises the wind turbine so that its blades safely clear the ground and so it can reach the stronger winds at higher elevations. Maximum tunnel height is optional in most cases, except where zoning restrictions apply. The decision of what height tower to use will be based on the cost of taller towers versus the value of the increase in energy production resulting from their use. Studies have shown that the added cost of increasing tower height is often justified by the added power generated from the stronger winds. Larger wind turbines are usually mounted on towers ranging from 40 to 70 meters tall

Proposed Design of the Wind Turbine

Fig.4-The blades of the turbine

The outer frame of tunnel like structure are made of aluminum. Shroud Researches have proved that the diffuser augmented wind turbine is the most efficient wind turbine. The wind enters the diffuser shroud at the inlet to the turbine, getting to the exit of the turbine there is a pressure drop which creates a partial vacuum that sucks more air into the turbine, thereby increasing the amount of wind flowing through the turbine blade and hence the output power is increased. In addition to the power augmentation, the shroud helps in protecting the turbine blade, the main shaft, the main bearing and the generator from external harsh conditions like rain fall and sun shine. The base of the shroud serves as the main support of the inner components of the turbine. The material for the shroud is aluminum alloy because of its high strength and light weight.

Fig.5- Model of outer shell of turbine

Principle of Operation

When the vehicle starts moving, it displaces the air which is directly in front of it. This causes the surrounding air to flow relative to the moving vehicle in a direction opposite to that of the vehicle. The opposing air stream directly in front of the turbine passes through the turbine blades thereby providing a torque which rotates the rotor.

Fig.6- The fabricated model

The rotational energy of the rotor is then transferred to the generator through the main shaft. The generator is electrically connected to the charging system of the vehicle. The batteries are therefore charged continually, while the vehicle is moving. The vehicle has already interacted with this wind and it deflects the stream of wind at the two sides of it by stagnation at the front. This is the energy that had been lost from the vehicle to overcome the aerodynamic resistant. Now if these stream generated by the interaction of the wind and vehicle is captured within the vehicle in such a way that it would not impose an additional drag at the direction of propulsion of the vehicle, some of the energy can be recovered and fed back to the battery by means of conventional energy conversion processes. Placing a wind turbine can serve the purpose.

3D-model of the design

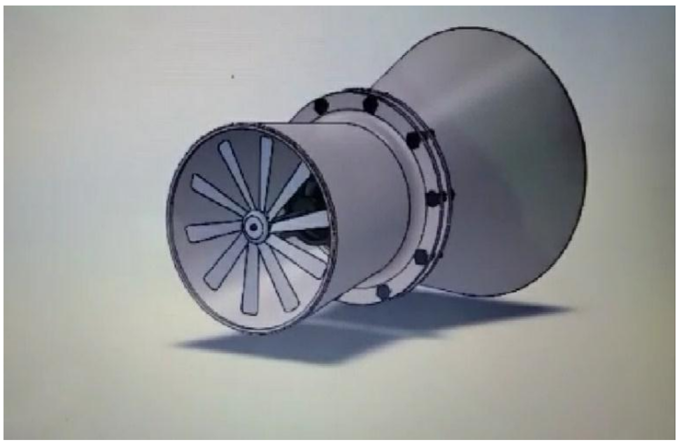

Fig.7- Simulation of the model

Literature review

Gideon Quarte, proposed a project on creating a portable turbine system with a shaft connected to the turbine and the motor to increase torque power on moving vehicle and also experimented on the forces acting on the shaft.

Asis Sarkar, et al proposed the idea of the turbine in a moving car and analyzed the power output from various blade length, no.of blades and the size of blades and focused o energy extraction by modifying the blade types.

S.M.Ferdous, et al proposed a design of a model with ducts on either side of the hollow block where the air flows through inside to the turbine and it is placed symmetrical and not parallel to the flow of air as to avoid the opposing thrust of air flow.

Thrishna jayaraj, et al proposed the idea of using both solar and wind power where both charge the battery of the vehicle and also regenerative braking to alternatively power the vehicle without the high use of fossil fuels.

Feng-tsai weng, et al investigated the amount energy restored in the battery when the car is in motion and found that it is efficient at higher speed of about 80km/hr and higher the speed higher the efficiency.

Stephane allard, et al compared the idea of smart charging by in Norway where in 60 households 37 EV's owned are charged from the grid where the power supply is in a source of wind energy.

Design calculations

We can consider a vehicle which is redesigned to allow airflow and wind turbine can be set up to extract energy. Wind turbines are set in parallel with the flow of air. This set up will not create any additional thrust at the direction of propulsion. Two basic equations will be needed to explain the air flow and power extraction. The air flow through the vehicle is given by,

Q = Cv A v

Where, Q = flow rate in cubic meter per second.

Cv = opening effectiveness

[Value for Cv is 0.5 - 0.6 for perpendicular flow and 0.25 – 0.35 for skewed flow]

A = Area in square meter

v = air velocity in m/s

This equation will determine the amount of air flow through the vehicle inlet area.

The velocity still air is known to be zero. So the velocity of air is considered to velocity of moving vehicle

The air flowing through the turbine in density is 1.225kg/m^2

Output power from a wind turbine is given by ,

PT = 0.5 CP ρ Q v2

Where,

PT = Power output from the turbine in watt. Cp = Power co-efficient

(Assuming, Cp = 0.4 for the design)

ρ = air density; 1.225 kg/m3.

Q = air flow in m3/s.

v = air velocity in m/s.

output power from wind turbine is

For calculating power,

we can calculate the amount of air flow,

$Q = Cv\ A\ v = 0.25 \times 0.8 \times 1.131 \times 15 \times 2 = 6.8$ m3/s

Here, $A = \pi r2 = 3.14 \times 0.62 = 1.131$ m2

v = 54 kmph = 15m/s

Here multiplier of Cv is 0.8 as ratio of the inlet and outlet area is 1.38.

Cv is chosen as 0.25 as it is a skewed flow .

So, Power, $Pw = 2\ 1\ \rho\ Q\ v2 = 2\ 1 \times 1.2 \times 6.8 \times 15 = 918$ W

Assuming, Cp = 0.4 Then we have,

$PT = 918 \times 0.4 = 367.2\ W \approx 360$ W

So, turbine will produce a power of 180 W. This much power will be fed back to the battery when it is moving at a constant velocity of 15m/s or 15km/hr.

There is a loss of about 24% in the energy. This is due to the feeding back of some of the energy captured by the turbine which is spend to overcome the aerodynamic drag. That means the turbines are capturing some fractions of the energy which has already been spend by the vehicle to overcome the aerodynamic drag.

Summary/Conclusions

The main concern with this model is that whether this design will create any extra resistive forces opposite to the direction of the propulsion. It has been identified by the simulation that a drag will be occurred due to addition of turbine. Overall simulation results a will suggest that the overall effect will be same which means the modified design will experience almost same amount of drag compare to the conventional one. But the addition of turbines may give the advantage of capturing some energy which will offer some benefits for the vehicle as discussed e. A physical structure of the design should be used to carry out wind tunnel tests which are seen at the bottom to be bolted down to the roof of the car. At first the system may resemble with perpetual motion. But a careful observation may indicate that the system is trying to recover some of the energy spend to overcome the aerodynamic drag. We believe it requires more research and elaborate analysis which we expect to continue in future. The wind turbine is appropriately designed to extract maximum amount of energy from the wind to power the electric car. Through the theoretical calculation on the power generated from the wind, a significant amount of electrical power is restored to the batteries when the car is moving at a speed of 120 km/h approx. It is recommended that another research should be conducted to find out the extent to which the power generated by the turbine can increase the driving range of the electric car. It is also recommended that more research should be done in order to incorporate the turbine design into the body of the electric cars.

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