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Original Article

Charging of Car Battery in Electric Vehicle Using Wind Energy

A. Marimuthu[1], K. Karthi[2], K. Shyam[3], R. Namasivaya[4]
[1,2,3,4]*K.L.N. College of Engineering Pottapalayam, Sivaganga, Tamilnadu, India.*

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Abstract: *The battery is a storage unit which consists of many cells, is used to produce power by undergoing some chemical process so that chemical energy is produced, and converted into electric energy, that is used as a source of power in vehicles. In conventional Engine vehicles, the batteries are used only to power the components like starter motor, horn and so on. Thus, the rate of battery discharging is slow. But today, the world is moving towards the production and use of Electric Vehicles (EV's), in which batteries are the primary source of power. This demand for batteries with larger capacity for EV's. Even though high-power capacity batteries are used, they tend to discharge at a much faster rate and demands charging every day. To charge these batteries, there must be very high-power input and also the charging time is more (3 to 4 h for full charge). Due to this disadvantage, people do not prefer EV's. Thus, the concept is to introduce a system which can charge the battery when the vehicle is in motion i.e., without stopping the vehicle for charging. To enable this, the most renewable source of energy is being utilized which is Wind Energy. To harness this wind energy, the Vertical Axis Wind Turbine (VAWT) is used. The VAWT will be placed inside the front grille of the vehicle where there will be air flow, which will propel the turbine, and thus power is generated. This system is capable of reducing the time and money spent for battery charging in the EV's.*

Keywords: *Battery, EV's, Charging, Wind energy, VAWT, Grille, Airflow.*

I. INTRODUCTION

The Battery is a storage unit that consists of number of cells, which is used to produce electric power by undergoing some chemical process so that there will be production of chemical energy and that will be converted into electric energy which can be used as a source of power for the electric components in the vehicle. There are many types of batteries like the Lead Acid battery, the Nickel Cadmium (NiCd) battery, the Nickel-Metal Hydride (NiMH) battery, the Lithium-ion battery and the Lithium Polymer battery that is being used to produce power for various needs. In Internal Combustion (IC) Engine vehicles, the most commonly used type of battery is the Lead Acid battery and in Electric Vehicles (EV's), the Lithium-ion battery and the Lithium polymer battery is being used in large size (as battery packs) to meet its demand for large power supply. The main functional components of these batteries are the positive electrode, the negative electrode and an electrolyte in the form of solution or a solid and other component includes the separators, terminals and caps, the container and connecting wire harness.

In lead acid batteries, the positive electrode is a plate covered with a paste of lead oxide and the negative electrode is plate of lead. The electrolyte used in this battery is water and sulphuric acid. In the Lithium- ion batteries, the positive electrode is lithium metal oxide and the negative electrode consists of porous carbon and the electrolyte is a lithium salt in an organic solvent. The positive and negative electrodes will be connected by conducting wires in which, there will be electrons flow from one terminal to the other terminal by which, the electricity will be produced. The lead acid battery that are used in IC (Internal Combustion) engines will supply very less amount of power and will not discharge easily, whereas the lithium-ion battery or the lithium- polymer battery in the EV's will have to supply power continuously so that the vehicle could propel.

Thus, the battery in the EV's will discharge very soon and requires charging frequently. But the fact is, the batteries in the EV's cannot be charged when the vehicle is moving. And also, these kinds of batteries will demand for more power supply for a long time period. This will have a direct effecting increasing the cost spent for electricity. Due to this, people will not consider making EV's as their transport vehicle; instead they will prefer the conventional Internal Combustion (IC) engine vehicles. So, there must be a solution to enable charging of the batteries in the EV's when the vehicle is in motion that could increase the vehicle's travel range without increasing the cost spent on charging the vehicle. Here, the solution is to introduce a system that enables charging of the battery in the vehicle when the vehicle is in motion i.e., without stopping the vehicle for charging.

This is done by utilizing the most renewable source of energy that is the Wind Energy. During vehicle motion, there will be flow of wind into the vehicle front portion through the vehicle grille. Depending upon the speed of the vehicle, there will be variation in the amount of air that enters the vehicle. If the vehicle moves at low speed, then there will be less airflow. If the vehicle moves at higher speed, then there will be more airflow. This air will be utilized to produce the necessary power required for charging the battery in the EV's. To harness this incoming air, the Vertical Axis Wind Turbine or the VAWT is being used [1]. In general, there are two types of wind tur-bines, the Vertical Axis Wind Turbine (VAWT) and the Horizontal Axis Wind Turbine (HAWT) [2]. The main reason for selecting VAWT is its compact structure, that can be fixed in place which has very small area available [3]. And also, the size to power ratio is also high when compared to the HAWT turbine. This VAWT turbine will be placed inside the front grille portion of the vehicle where there will be airflow into the vehicle.

The power generated by fixing the wind mill on road highways. When the vehicle is moving at high speed then the turbine rotates and generates power. This analysis shows that when the vehicle moves at a speed of 25 m/s then the VAWT is able to produce 1 kW power. The efficiency of the VAWT can be increased by modifying its size and shape of the blade.

The vertical and horizontal wind mills to produce clean energy. The horizontal wind mill is highly preferred for large scale power production and requires massive investment. Whereas the vertical wind mill is suitable for domestic application and at low cost. The generation of electricity is affected by the geometry and orientation of blades in the wind turbine. To optimize efficiency of VAWT, design parameter of turbine blade plays a vital role. The experimental result also indicates that the blades have a significant role in the performance and energy production of the turbine.

The wind mill with belt transmission system for producing electrical power. The blade and the drag devices are being designed in the ratio of 1:3 to the turbine. The experiment was conducted at different wind speeds and the power produced by the wind turbine is calculated. The experimental result showed that 567 Watts of electrical power is produced at the speed of 20 m/s while 709 Watts of electrical power is produced at the speed of 25 m/s. Form this investigation it is concluded that increasing the speed of the wind mill, the power production will increase.

VAWT is more efficient than HAWT because it requires compact space for producing same amount of electricity and less noise. The results of this paper indicate that the efficiency of turbine may reduce due to its manufacturing error and even frictional losses. It will be rectified by precision aerodynamic design of the blade.

The design of small scale VAWT which is economical and also affordable to the consumers to harness the wind energy to produce small scale electricity. It can be used in rural areas to improve the living condition of the people with a low cost electricity generation. Combined vertical axis wind turbine. In this paper, the increased efficiency is achieved based on the characteristics such as aspect ratio, tip speed ratio, velocity and other geometry parameter. The experiment is con- ducted mainly to increase the power production and efficiency of the turbine. The development of the design is optimized by combining the blade structure and the flow performance. The result obtained indicates that the efficiency of turbine is always based on the wind speed and also the climatic conditions. The lowest aspect ratio improves the power coefficient of the turbine.

Designing a system for harnessing the wind energy to charge the battery of a vehicle, whether the vehicle is parked or in motion. In this paper, he pro- posed a roof-mounted internal wind turbine that will harness the wind energy when the vehicle is in motion and causes rotation of the shaft of an electric generator mounted to the interior surface of the roof and also an external wind turbine is attached to the internal wind turbine in which, the cups that are used in cup anemometers are attached to the radial arms that extend from an external shaft of the external wind turbine to harness wind cur- rents when vehicle is parked, causing the external shaft and the generator shaft to rotate.

Design and implementation of a vehicle wind turbine that can be attached in electric cars to generate electric power to charge the car batteries when in motion. In this paper, a portable horizontal axis diffuser augmented wind turbine is adopted for the design as it is able to produce higher power output when compared to the conventional bare wind turbines. Based on the research, when the car is moving at a speed of 120 km/h, a significant amount of electric power (3.26 kW) is restored to the batteries.

The performance and life cycle assessment of a small scale vertical axis wind turbine. In this paper, a real case of a H-Rotor 5 kW Durries vertical axis wind turbine in Poland is investigated for its performance using actual generation data. More importantly, a life cycle assessment (LCA) is undertaken, by compiling a very detailed life cycle inventory basedon primary data and two scenarios were examined for the end-of- life treatment, including recycling and incineration. The performance assessment results show that the actual performance is very poor mainly due to the low wind speed. For this reason, a series of hypothetical capacity factors were used to facilitate comparison with other studies

A. Layout of the Battery Charging System

Fig. 1 shows the layout of experimental setup of battery charging system is mainly focused on the fact that there must be a sys- tem which is capable of charging those high capacity batteries that are employed in the Electric Vehicles (EV's) with very minimum amount of loss in power and must also be highly effective so that the system will be of more benefit to the consumers of those Electric Vehicles. This system consists of the most efficient components that will provide the necessary amount of power without affecting the performance of the vehicle. This system proposed can be used for any batteries which are used in the automotive sector. Experiment was carried out with a 35 Ah and 12 V batteries.

Considering the fact that there will be very less space available at the front portion of the vehicle, this system is designed in such a compact and efficient manner so that this system could be attached into that space available. This system functions mainly depending upon the speed of the vehicle such that when vehicle travels at a particular speed, there will be production of power at that speed and when the speed varies, the power output will also vary. To encounter this phenomenon, the system consists of several components which ensures continuous and constant power supply to the battery so that there will be uninterrupted charging of the battery.

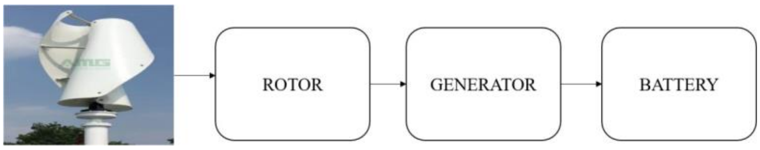

Figure 1: Layout of Experimental Setup

B. Design of Vertical Axis Wind Turbine (VAWT)

The vertical axis wind turbine or the VAWT is the advanced typeof wind turbine that is being employed to harness the wind and produce wind energy all around the globe. The main reason for employing this VAWT is due to the fact that this can be used in locations and places where there will be very minimal space available. Some examples of places include parks, home terrace, and much more.

To design this VAWT depending on the availability of space and power requirement, there are some formulae that are being applied so that the exact dimensions of the VAWT could be obtained for optimal functioning of the power supplying system. The wind power is calculated by using the formulae (1).

Nw ¼ q · S · V3=2 ð1Þ

Where,
Nt — Power of wind turbine
q — Density of air
S – Area of the turbine
V – Velocity of wind

The turbine power is calculated by using the formulae (2)

NT ¼ q · S · V3=2:COP ð2Þ

Where,
NT — Power energy of turbine
COP— Coefficient of Performance (0.1–0.2 for small turbines)

From the above formulae, the dimensions of the VAWT blade and the number of blades required is calculated and used by CATIA V5 software to the 3D view of VAWT Turbine blade is design as shown in Fig. 2. From the above design, the total turbine is being designed by using the CATIA V5 software to the 3D view of VAWT Turbine is design as shown in Fig. 3. Thus, the prototype of VAWT turbine is shown in Fig. 4 and dimensions are given in Table 1. It is fabricated by using Aluminumas the primary material due to its lightweight and high resistance to corrosion properties. This VAWT is designed for producing 0.5 kW of energy when the vehicle is running at 40–60 kmph.

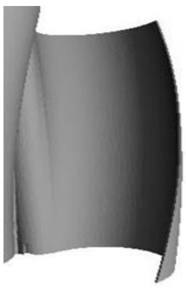

Figure 2: 3D Design of VAWT Turbine Blade using CATIA V5 Software

C. Generator

The Generator is a device that is used to produce electric power by converting the mechanical energy into the electric energy. Here, a 12v DC (Direct Current) generator is shown in Fig. 5. It is used to convert the mechanical energy that is obtained from the VAWTinto useful electrical energy. Since we require DC (Direct Current) supply for charging the battery, the DC Generator is being usedin this system.

Figure 3: 3D Design of VAWT Turbine using CATIA V5 Software

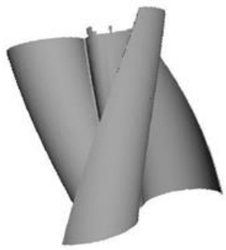

Figure 4: Prototype of VAWT Turbine

Table 1: Dimensions of VAWT Turbine

Parameters	Turbine Dimensions
Overall Diameter	60 mm
Overall Length	250 mm Length of the blades, 200 mm Area of the blades, 12000 mm2
Number of Blades	5

D. Power Boost Converter (DC):

The Power Boost Converter is a device that is being used to boost the output voltage from the voltage source. The voltage fromthe VAWT turbine will be less due to the reason of small area of theturbine and thus this boost converter will be used to boost the voltage to the required range. Here the DC to DC Power Boost Con- verter is shown in Fig. 6 being used so that there will be increased voltage output that can be utilized for battery charging in the Electric Vehicles (EV's).

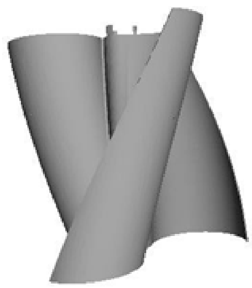

Figure 5: 12 V DC Generators

Figure 6: Power Boost Converter (DC)

E. Voltage Regulator

The Voltage Regulator is shown in Fig. 7 used for regulating a constant voltage throughout the circuit. The circuit consists of capacitors, diodes, along with the voltage regulator to regulate the voltage. The series number of 12v is L7812CV. A voltage regulator module which is readily available is being used.

II. RESULT AND DISCUSSION

The proposed design of the battery charging system is capable of producing the required power output that is required for charging the batteries that is being used in the Electric Vehicles in an efficient manner [13]. This system functions in such a way that there is no change in the efficiency of the vehicle operation. Even though this system depends mainly on the vehicle speed that varies all the time, the system is able to produce constant power continuously so that the battery charging is uninterrupted. Low cost, efficient, clean wind energy based power production and placing of turbine in the high flow area are effectively used to charge the battery.

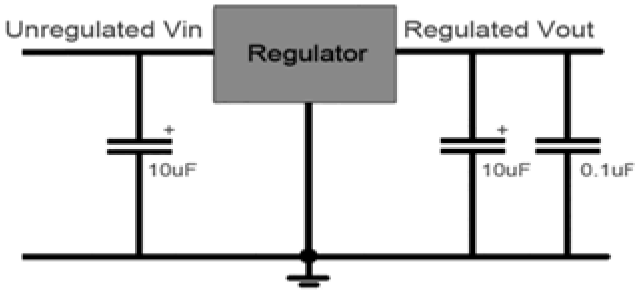

Figure 7: Voltage Regulator Circuit

II. CONCLUSION

The future of the automotive industry depends majorly on Electric Vehicles due to the main factor of reducing the polluting gases that is emitted from the IC (Internal Combustion) Engine vehicles. But the main drawback of those Electric Vehicles is that the range of operation is very less when compared with those of the IC (Internal Combustion) Engine vehicles and another important drawbackis the charging of those huge capacity batteries. The battery charging time is very high, and these reasons are being an obstacle for implementation of these non-polluting Electric Vehicles in operation. Thus, with the employment of this proposed battery charging system in the Electric Vehicles the range of operation of those vehicles could be increased and also the time required to charge those batteries can also be reduced.

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