Improvement of Electric Vehicle Efficiency

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Abstract- *At present, transportation is done mainly with the help of fuel vehicles. They helpful in transporting people, goods, animals and other loads from one place to other within a short period of time. But the main drawback in fuel vehicles are air pollution, unavailability of fuel and fuel cost. Hence, many kinds of fuel engines emerged the vehicle market to overcome these problems but they cannot reduce the problems completely. To overcome the above drawbacks, electric vehicle emerged the vehicle market by replacing the fuel by battery and engine by Brushless DC motor this reduced the smoke production completely and the fuel cost is reduced nominally. But due to in sufficient charging stations and low millage these vehicles have a poor market. This project is to overcome the drawbacks in electric vehicle. In this project, we can generate electric energy when the vehicle is in motion and the generated energy is stored in a battery so that it can be used to run the vehicle further after the main batter gets drained off. It is done by replaced the front wheel by a generator which helps in generating electric energy using rotation of the wheel. The generated AC is converted into DC with the help of a AC to DC converter and it is stored in another battery.*

Keywords- BLDC (Brush Less Direct Current) Motor,Lead Acid Battery, Rectifier, Switching circuit,Vehicle testing(ON and OFF Road)

I. INTRODUCTION

Electric Vehicle is an electromechanical machine and used for domestic transportation purposes. Many related vehicles are manufactured and reached the vehicle market for replacing the fuel vehicles. Initially the main focus was to reduce the pollution and smoke that are produced by the fuel vehicles. Electric Vehicles have entered almost every country, now in India as well. Since the day Electric Vehicle have entered the market many changes taken place in domestic transportation. The concept of electric vehicle had been started in 1835 by an American named Thomas Davenport and in early 1990's American's started developing the fully working electric vehicles but in 2003 they dropped the usage of these vehicles. In the year 2009, these vehicles hit the market in India. They looked similar to a scooter and it is recharge able with a charger externally.But the market drops and again overtaken by the fuel vehicles due to insufficient power to travel a long distance with a single charge, time taken to charge the batteries is too high so that frequent usage of electric vehicle is not possible, the maximum speed is 25Km/hr so that it cannot be used for emergency situations. Many projects related to improve the efficiency of the electric vehicle is done. This project is also all about improving the efficiency by generating and storing the energy generated during vehicle is in motion and storing the energy for further motion after draining the main source of energy.

II. LITERATURE SURVEY

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An overview of the present status and future trends in electric vehicle technology is provided. The emphasis is on the impact of rapid development of electric motors, power electronics, microelectronics, and new materials. Comparisons are made among various electric drive systems and battery systems. The market size of electric vehicles in the coming years and the potential electric vehicle impacts are discussed.

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A growing awareness of environmental protection and energy conservation are forcing the development of electric vehicle technology. Electricity is more than just another means of powering the vehicle. The EV requires an energy storing system which is one of the concerns of today's EV technology. Batteries are the energy storage means for EVs. Specific energy and specific power of electrochemical batteries are generally much smaller than those of gasoline. A large number of batteries are required to assure a desired level of performance, which leads to an increase in the vehicle weight, cost and the degradation of vehicle performance. This paper discusses the battery technology for the electrical vehicles in which discussions are made on the set of criteria including specific energy, specific power, energy efficiency, charging rate, cycle life, operating environment, cost, recycling and safety. Various advanced batteries recommended for EV systems, have been discussed in this paper which gives a clear concept and idea of selection of batteries and associated circuits. A number of charging

schemes like home charge, regenerative charge, solar charge, park and charge etc. have also been discussed.

III. HARDWARE COMPONENTS

The hardware components include electrical, electronic and mechanical parts which performs particular task. The mechanical parts used are electric vehicle chase, fibre body out fits, tyres and suspensions. The electrical parts used are BLDC motor, batteries, converter, BLDC controller, and lights. The electronic parts include AC to DC rectifier circuit and battery switching circuit.

A. *BLDC (Brush Less Direct Current) Motor*

A brushless DC motor (known as BLDC) is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system (commutation is the process of producing rotational torque in the motor by changing phase currents through it at appropriate times) instead of a mechanically commutation system. BLDC motors are also referred as trapezoidal permanent magnet motors. Unlike conventional brushed type DC motor, wherein the brushes make the mechanical contact with commutator on the rotor so as to form an electric path between a DC electric source and rotor armature windings, BLDC motor employs electrical commutation with permanent magnet rotor and a stator with a sequence of coils. In this motor, permanent magnet (or field poles) rotates and current carrying conductors are fixed. The armature coils are switched electronically by transistors or silicon controlled rectifiers at the correct rotor position in such a way that armature field is in space quadrature with the rotor field poles. Hence the force acting on the rotor causes it to rotate. Hall sensors or rotary encoders are most commonly used to sense the position of the rotor and are positioned around the stator. The rotor position feedback from the sensor helps to determine when to switch the armature current. This electronic commutation arrangement eliminates the commutator arrangement and brushes in a DC motor and hence more reliable and less noisy operation is achieved. Due to the absence of brushes BLDC motors are capable to run at high speeds. The efficiency of BLDC motors is typically 85 to 90 percent, whereas as brushed type DC motors are 75 to 80 percent efficient. There are wide varieties of BLDC motors available ranging from small power range to fractional horsepower, integral horsepower and large power ranges.

Figure 1: BLDC Generator

B. *Lead Acid Battery*

The battery which uses sponge lead and lead peroxide for the conversion of the chemical energy into electrical power, such type of battery is called a lead acid battery. The lead acid battery is most commonly used in the power stations and substations because it has higher cell voltage and lower cost.

Figure 2: External Battery setup

C. *DC to DC converter*

The output voltage of DC to DC converter can be lower than the input voltage or vice versa. The converter output voltages are used to match the power supply required to the loads. The connection and disconnection of power supply to the load can be controlled using a switch in the simple DC to DC converter circuit.

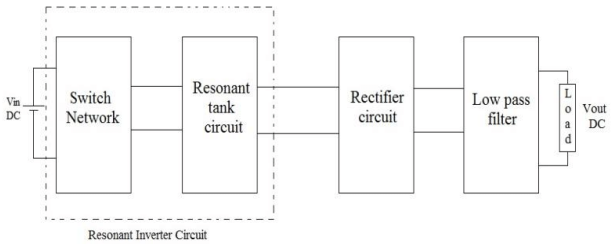


Figure 3: DC to DC Converter Block Diagram

A DC to DC converter is used to convert the input 48V DC to 12V DC which is used to supply the headlights, indicator lights, horn and emergency lights. As well as it consists of Over current protection, Short circuit protection, Low voltage protection in order to protect the components that are connected with it.

D. Rectifier

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification. The DC output is filtered with the help of a capacitor bank and it is selected as per the load requirement.

E. *Chassis*

A chassis consists of an internal framework that supports a man-made object. An example of a chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted) with the wheels and machinery. In the case of vehicles, the term chassis means the frame plus the running gear like engine, transmission, driveshaft, differential, and suspension. A body, which is usually not necessary for integrity of the structure, is built on the chassis to complete the vehicle. The automotive chassis is tasked with holding all the components together while driving and transferring vertical and lateral loads, caused by accelerations, on the chassis through the suspension and the wheels. Therefore, the chassis is considered as the most important element of the vehicle as it holds all the parts and components together. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. Chassis frame forms the backbone of an electric vehicle, its principle function is to safely carry the economical load for all designed operating conditions. It is essential that the frame should not buckle on uneven road surfaces and that any distortions which may occur should not be transmitted to the body. The frame must therefore be torsion resistant. Weight optimization is now the main issue in automobile industries. Weight optimization will give substantial impact to battery usage, and therefore, save environment. Aluminium alloys is commonly used chassis material at present in electric vehicles.

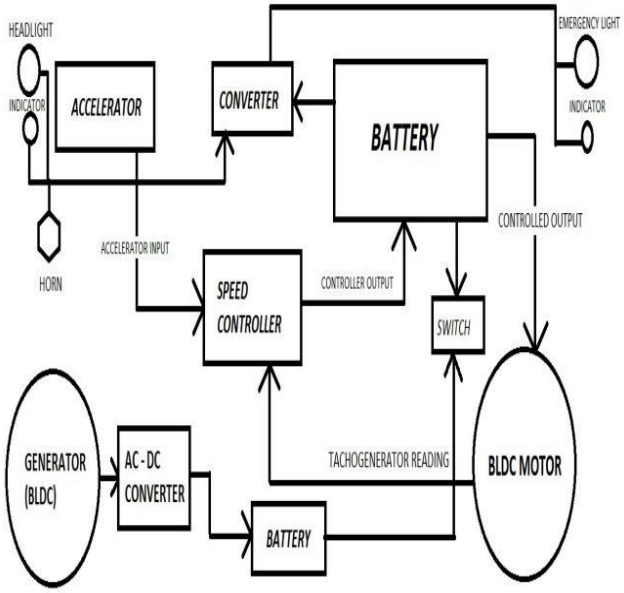
Figure 4: Electric vehicle chassis

Tyres

A tyre is a rubber covering, typically inflated or surrounding an inflated inner tube, placed round a wheel to form a soft contact with the road.

IV. PROJEST RESULTS AND DETAILS

A. Block Diagram



Electric vehicle is normally constructed with motor fed with a battery source and a charger port to charge the battery externally. This construction is controlled with the help of speed controller which helps to maintain the speed of the vehicle less than or equal to 30km/hr. The input (required by the vehicle) is fed through accelerator and the controller will compare the input from accelerator and reference output from motor to give a controlled voltage from battery to motor. This operation will stop when the battery gets drained off, then we need to charge the battery for further usage. In this project, the front wheel is replaced by a (BLDC) generator which starts to rotate while the vehicle is in motion. The generated energy is fed through a rectifier which converts the 3 phase AC to DC

by means of the diode circuit.The output of the rectifier is in the form of fluctuating DC and to get a constant DC a capacitor bank is connected across the output terminals of the rectifier. The converted output is taken across the capacitor bank and the it is given to another battery which gets charged while the other battery is in use.

B. *Switching operation*

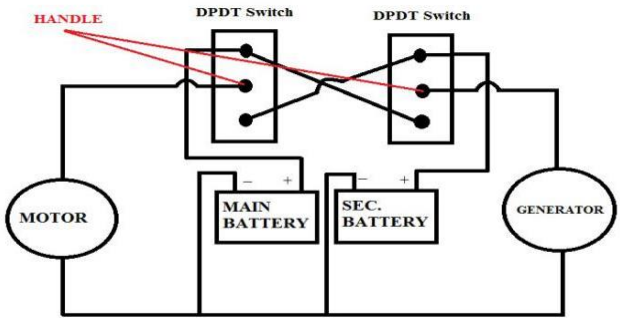


Figure 5: Switching system circuit diagram

In this system the DPDT switch will be in off state when it is at the middle. If the handle switched down, the motor is connected to the main battery for running and the generator is connected with the secondary battery for charging. If the handle switched up, the motor is connected to the secondary battery for running and the generator is connected with the main battery for charging. This switching system helps to charge both the batteries, so that both the batteries can be used for travelling a long distance.

Figure 6: Switching circuit

C. Vehicle testing

1) OFF Road test

Electric vehicle is tested under the off-road condition or stand still condition without applying any load and the reading are given in the table

Table 1: Off road Readings

Vehicle Speed (Km/hr)	Motor Speed (RPM)	Current (A)	Voltage (V)	Power (W)	Efficieny (%)
5	136.5	0.6	52.3	31.38	12.5
10	205.4	0.8	52.1	41.68	16.6
15	274	1	51.9	51.9	20.7
20	340.6	1.1	51.5	56.65	22.6
25	414.5	1.3	51.4	66.82	26.7
30	483.4	1.5	51.2	76.8	30.7

2) ON Road test

In on road test, vehicle is tested under normal running condition in road and reading are taken which is given in the table

Table 2: On road Readings

Vehicle Speed (Km/hr)	Motor Speed (RPM)	Current (A)	Voltage (V)	Power (W)	Efficieny (%)
5	55	1.2	51.60	61.92	24.8
10	110	2	50.37	100.74	40.3
15	165	3.2	49.86	159.55	63.8
20	220	4.1	47.62	195.24	79.9
25	275	5.3	45.23	239.72	95.8
30	330	6.5	44.52	289.38	84.2

The load applied to the vehicle is Kerb weight of the Vehicle is 80Kg and a human average weight of 60Kg. Hence, the average weight of Indian human body is given on research done by Scientists of National Institute of Nutrition(NIN).

3) *Efficiency comparison*

Table 3: Efficiency Comparison

Speed (Km/hr)	5	10	15	20	25	30
OFF road (%)	12.5	16.6	20.7	22.6	26.7	30.7
ON road (%)	24.8	40.3	67.8	79.9	95.8	84.2

Efficiency of motor in OFF road is very less compared to the ON road efficiency as the power consumed by the motor is less compared to the rated power. The economic speed of this vehicle is 25 km/hr hence the motor attains its maximum efficiency at that speed and the top speed of vehicle is 30km/hr

V. CONCLUSION

1) Millage of electric vehicle before replacing generator. Eg: 50Km.
2) Millage of electric vehicle after replacing generator and adding battery. Eg:65Km
3) Efficiency of Electric vehicle with normal load of 140Kg with kerb weight of 80Kg and human weight of 60Kg (as per research done by Scientists of National Institute of Nutrition (NIN) on human body weight in India) is 50Km.
4) By replacing front wheel with generator, the kerb weight increases by 5Kg.
5) The electric vehicle runs for minimum of 2hr at a constant speed of 25Km/hr. By adding the secondary battery, the kerb weight increases by 30kg.
6) If the maximum output power (42V,2A) generated by the generator in 1hr will be equal to 84W/hr. The maximum power generated by the generated will be equal to 168W by the Generator. Increase in weight drop in millage by 7Km.
7) Power generated will charge the battery and helps to run the vehicle for another 22Km. By reducing the millage drop of 8Km due to increase in weight then we can gain 15Km(approximately 1.5 percentage efficiency improved) with the help of generated power.

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