Conversion of Petrol Bike to an Electric Bike

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Abstract
An electric vehicle is a type of vehicle that uses electric motor and battery pack instead of an internal combustion engine. Power is given from battery-pack rather than petrol. This saves money and has smaller impact on the environment as well. There are few barriers for the rapid adoption of electric vehicles, like lack of charging infrastructure, limitations of battery technology and high purchase costs. In this project, I am going to converting a petrol bike into electric bike using lithium-ion battery and BLDC motor.

Keywords: Electric Bike, Electric Vehicle Retrofitting

1. Introduction

Operating cost of the electric vehicles is less than that of gasoline powered vehicles. As price of fuel increasing, it is difficult to use internal combustion engine vehicles. The future of automobile is going to be electric. The pollution emitted by the automobiles is increasing rapidly nearly about 73% of total pollution due to the usage of internal combustion engines. If we go for newly launched electric vehicle, they are highly priced compare to conventional IC engine vehicle. Battery used by these EVs are costlier, they use lithium-ion batteries which prices around thousands. Obviously, everyone is looking towards making electric vehicles pocket friendly. There is a method of doing this is to converting an internal combustion engine (ICE) vehicle into an electric one. There are a number of kits on the market that can be utilized to do this conversion. Electric vehicles use batteries to power the vehicle, an electric motor as powertrain. For this conversion, the vehicle's gasoline engine, exhaust system, petrol tank, and clutch assembly will no longer be needed. Electric vehicle conversion is the replacement of a vehicle's combustion engine and connected components with an electric motor and batteries, to create an all-electric vehicle. Setup of my project consists of an ordinary bike, lithium-ion battery, a BLDC motor, a controller and wire harness. A new and improved design for the conversion of IC engine vehicle to electric vehicle was developed based on the literature review and the problem identification. The proposed design consists of electric rear wheel-drive with a BLDC motor, battery and chain drive.

2. Methodology

As electric vehicles are going to replace the existing IC engine vehicles, existing IC engine vehicles cannot be completely demolished. We can make use of these scrap vehicles by converting conventional gasoline powered vehicle into electric vehicles. A lot of vehicle scrap is collected every year which is creating pollution, so basically this is the problem identified in problem identification stage. Then in literature review stage, the patents, journals, online references were collected, studied in detail and the literature review was summarized. Based on the problem identification and literature review, the conversion of gasoline powered vehicles to electric vehicles was designed. Then the calculations were made to select the required components. After the fabrication work of our vehicle

with proposed design, the performance, efficiency, speed of the vehicle and also the load carrying capacity of the vehicle will be tested.

3. Components Used

1. Bike
2. BLDC motor
3. Lithium-ion battery
4. Controller
5. DC-DC converter
6. Charger

3.1 Bike

For this project, I have used a four-stroke gasoline powered bike. And then I removed engine, gearbox and other components. As I replaced these components with motor, battery and controller.

Photo 1: Selected Bike

3.2 BLDC Motor

For getting speed and high initial torque, a BLDC motor is preferred as it is good for the load carrying capacity, on considering the gross vehicle weight and the passenger weight this 48 V & 750 W motor is selected. This BLDC motor is powered by lithium-ion battery pack and is controlled by a controller. To change the speed, we can change the voltage for the coils. The voltage to the BLDC motor is controlled by the driving controller circuit.

Photo 2: BLDC Motor

3.3 Lithium-Ion Battery

The battery is the source of power supply to the motor. Selection of battery pack is an important part of an electric vehicle. I have done several calculations then I selected 48 V & 15 Ah NMC battery-pack. The lithium-ion battery has less weight compared to the lead acid battery and has high energy density and low self-discharge rate. Thus, the efficient battery that is required for driving the motor is to be used. Major consideration is weight of the battery and its power output for the rated speed.

3.4 Controller

While BLDC motors are mechanically relatively simple, they do require sophisticated control electronics and regulated power supplies. Thus, a 48 V drive controller is selected which is required to control the BLDC motor. The controller choosing for the project must match up with the battery specifications as well as with the motor specifications.

Photo 4: Controller

3.5 DC-DC Converter

Battery pack gives a fixed voltage, but the voltage requirement of different accessories such as horn, headlamps and turn indicators in the vehicle may vary. This device converts 48 V to 12 V as per requirements.

Photo 5: DC-DC Converter

3.6 Charger

For lithium-ion battery pack I have selected 48 V and 3 amp Li-Ion battery charger. Basically, a charger is a device that converts alternate current received through charge port to direct current and control the amount of current flowing into the battery pack.

Photo 6: Charger

4. Calculations

Load Calculation

The total load applied to the BLDC motor is calculated based on the following weight of the vehicle and its accessories.

Vehicle weight = 70 kg
Motor weight = 8 kg
Battery weight = 3 kg
Rider and accessories = 90 kg
Total load = 171 kg

Force Calculation

The force required to pull the calculated load is based on the total load of the vehicle. The force required is given by the formula $F = Crr \times M \times g$

Where,
F = Force in newton
Crr = Coefficient of rolling resistance = 0.01
M = Mass of the vehicle (total load)
g = Acceleration due to gravity = 9.81 m/s^2

$F = 0.01 \times 171 \times 9.81 = 16.77$ N

Power Calculation

Assuming the maximum velocity of 30 km/hr, the power required to pull the rated load is calculated by using the formula $P = F \times (V \div 3600)$

Where,
P = Power in watts
V = Velocity 30 km/h = 30000 m/h

$P = 16.77 \times (30000 \div 3600) = 140$ watts

Battery Calculation

The watt hour of the battery is given by wh = Ah × V

Where,
Ah = Ampere hour
V = Voltage

48 V × 15 Ah battery = 720 wh

Since the battery produces 720 watts hour, which is higher than required voltage, we can use this battery.

Distance Calculation

The distance that can be travelled using this battery is given by d = wh / F
d = 720 ÷ 16.77 = 43 km

The road conditions may not be same during the whole journey, so we can recalculate the distance that can be travelled by increasing the force that is required to run the vehicle:

d = wh ÷ F = 720 ÷ 20 = 36 km

Charging Time Calculation

The charging time of a Lithium-ion battery varies depending upon the charger used for it. The charging time of the battery is given by T = Ah / A

Where,
Ah = Ampere hour rating of battery
A = Current in amp (charger)

T = 15 ÷ 3 = 5 hours

Also, fast charging method can be used in future to reduce the charging time.

Required Units of Current Needed for Full Charge

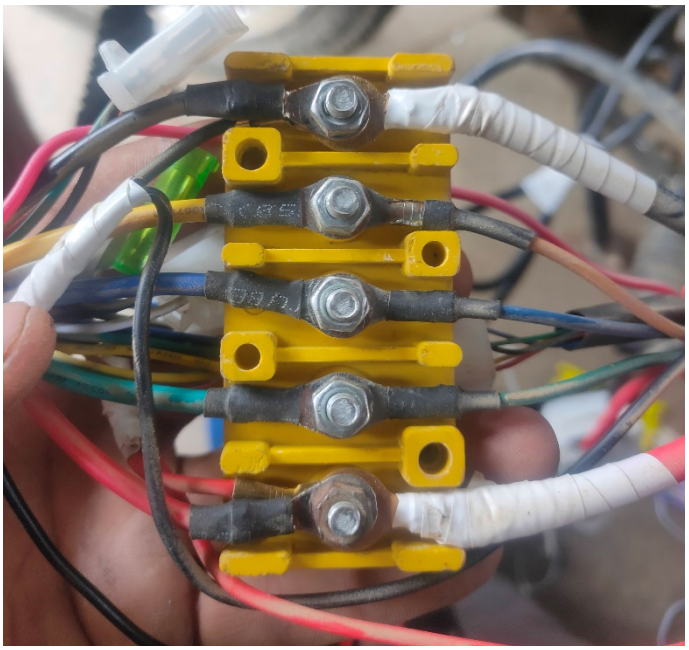
A 48 V & 15 Ah lithium-ion battery is used.
1 amp = 1.4 kVAh
∴ 15 amp = 15 ÷ 1.4 = 10.71 kVAh
kW = kVAh × Pf (power factor)
∴ 10.71 × 0.174 = 1.86 kW units are required.

5. Assembling of Components

lithium-ion battery and the BLDC motor has been assembled in the selected bike. All components are assembled in the vehicle without affecting the center of gravity. Motor is fitted on the place of engine and should not get protruded out of the vehicle. Battery is fitted above the motor. Controller has been placed under the seat for protection. By arranging these components at their desired locations, the vehicle is able to run at desired speed.

6. Working

The battery pack powers the motor and bike starts running. The motor is made to run with the help of lithium-ion battery. The specification of lithium-ion battery is about 48 V & 15 Ah. A 750 W motor is used for this project. The electric current from the battery is passed to the controller then the required amount of current will be flown into the motor. The voltage of the controller must match with the battery pack. A sine-wave controller is used for this project. The motor drives the rear wheel of the vehicle with the help of a chain drive. The range of the vehicle can be increased by increasing the battery capacity, and speed can be increased by selecting another motor. Battery can be charged with the selected charger.



The above figures shows the electrical connections that were made to the vehicle.

7. Test Report

I took mileage and top speed test for this project. The bike ran 40 km at a speed of 30 km/h with a single charge. 5 hours took to fully charge the battery pack. The components specifications and the test report outcome are shown in the below table:

Table 1: Specifications and Outcome Report

Battery	48 V & 15 Ah
Motor	48 V & 750 W
Controller	Sine-wave
Charger	48 V and 3 amp
DC-DC Converter	48 V to 12 V
Mileage	40 km
Speed	30 km/h
Charging time	5 hours

8. Results and Discussion

After completing this project, I took test drive and got these outputs. The vehicle can travel at a speed of 30 km/h. It can go up to 40 km on a single charge. The 750 W motor is giving good initial torque. By changing motor specifications and battery capacity, we can increase speed as well as range of the vehicle. Lithium-ion battery is used as it has comparatively less weight, long life span and supports fast charging.

9. Contribution to the Society

By converting petrol-run bike to electrical, we can make use of scrap vehicles. And this will be an affordable solution as an EV. We can protect the environment by reducing the usage of petrol.