Conversion of IC Engine Bike into Electric Motor Bike

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Abstract - For the past 132 years mankind has relied upon I.C. engine vehicles for day to day transportation. These I.C. engines use fossil fuels to operate resulting in highly toxic gases and noise. An electric powered bike can be a good solution towards this problem. But existing I.C. engine bikes will pose a problem of depreciation and disposal. Hence converting these I.C. engine vehicles to electric can be a great way to overcome many existing problems.

Key Words: E-bike, green energy, customizable, Electric motor, affordable, conversion.

1. INTRODUCTION

Technology is developing fast and every day new developments are being done. Technology is a boon to many but it has its own limitations like driving a conventional I.C. engine bikes is expensive and also damage the environment. Also I.C. engine bikes require regular maintenance and operating cost is comparatively high. E-bikes is a possible solution to this problem but initial cost to buy one is much high. Today the e-bikes available are somewhat impractical in design and use in day to day life and are not suitable for Indian transport conditions.

This project aims to mitigate the above listed problems by designing and converting an I.C. engine bike to an E-bike which will be driven by an electric motor with simplified mechanical chain drive system eliminating gear mechanism.

2. LITERATURE REVIEW

There are different type of vehicle developed are sports bikes, low powered commuter scooters, E-bikes, Solar operated two wheelers etc. Current cost of E-bike in market is around 70000. Hybrid E-vehicles are bulky and impractical. Solar vehicles requires photovoltaic cells which are high in cost.

Jiejunyi Liang, Haitao Yang, Jinglai Wu, Nong Zhang, Paul D. Walker [1] discussed various modes of transport available and suitable for short distance travel. The modes are classified as per the maneuverity, ease, automation and comfort. Also considering advantages and drawbacks of each motor type, suggestions are made for use of proper vehicles as per the person's requirement. To overcome the problems of IC engine vehicles E-vehicles are developed but their travelling range is limited due to sophistication of the machinery. For long distance travelling and comfort of the person, retrofitted moped bikes and modified cars are developed. The main drawback with this was, the person making use of electric cars needs to charge it from time to time making it a difficult task. Also such vehicles are not affordable for every person. Thus, it discusses the need to develop a mode of transport for common man which is not highly costly.

M.A. Kluger, D.M. Long [2] stated importance of electric vehicles. Electric vehicles, which use 100% electric power, use electric motors instead of an internal combustion engine to provide motive force. Solar-powered vehicles use photovoltaic cells to convert sunlight into electricity. The electricity goes either directly to an electric motor powering the vehicle, or to a special storage battery. PV cells produce electricity only when the sun is shining. Without sunlight, a solar powered car depends on electricity stored in its batteries.

R. Maruthi Prasad*, A. Krishnamoorthy [3] have taken a new step in solar power source innovation by using a split power solar power source to drive an electric vehicle instead of the conventional solar panel. They have made a

definitive point by proving their innovation is indeed superior to the conventional solar panels in every aspect necessary. Thus an important innovation in solar power sources is made and it shall help in increasing the sustainability as well as range of E-vehicles.

3. DESIGN CALCULATION

Component	Mass (kg)
Frame	40
Battery	27.2
Rider	80
Motor	7
Controller	1.5
Accessories	1
Total	156.7 kg

3.2 Running Parameters

As vehicle is being designed for average person and speed is up to 50 kmph. Diameter of wheel is 254 mm (10 inch) thus rotational speed of wheel is limited to 1044 rpm.

Motor must overcome following resistances while driving.

1. Air Resistance (Ra) = 3.8 N

2. Gradient Resistance (Rg) = GVW × SinΘ
   Θ = 1 to 7 degrees
   GVW = 1552 N
   Rg = 1552 × sin 6.5 = 172.634 N

3. Rolling Resistance (Rr) = μ × GVW
   Rr = 0.023 × 1552
   Rr = 35.696 N

4. Inertia Force, F = m × a
   Taking acceleration as 1.157 m/s^2
   F = 156.7 × 1.157 = 181.365 N

5. Reduction Ratio (G)
   For 50 kmph Vehicle speed
   = Motor RPM / Wheel RPM
   = 3000 / 1044
   = 2.8

3.3 Energy consumed by batteries

No of batteries used in the E-bike are four.
Battery has the following specification:

- Type: Silicone Gel E-bike battery
- Battery Rating : 28 Ah
- Voltage :12V
- Total Voltage:12 × 4 = 48 V

Energy consumption in 1 hour
= Ah rating × Voltage
= 28 × 48
= 1344 Wh or 1.3 kWh

Given Silicone Gel batteries have capacity of 28Ah, hence time taken per charge is -

= Battery capacity / Charging current
= 28 / 3.5
= 8 Hours

Tariff of MSEB = 6 rupees / unit for residential meter connection. (Average tariff)

Now charges for given energy consumption

= Units consumed × Cost per unit
= 1.344 × 6
= 8 rupees

In a single charge vehicle covers maximum distance of 30 - 40 km, Cost per km can be found easily

= Cost per charge / km covered per charge
= 8 / 33.6
= 0.238 Rs. / km

4. COMPONENT SELECTION

E-bike consist of various components like motor and controller, Frame, batteries and speed control and brakes.

4.1 Frame

Frame is the supporting member of the E-bike and subjected to static and dynamic load. It also takes various load like vertical load, cornering load, side thrust, acceleration and brake dip. Various accessories and components are mounted over the frame. A frame should have sufficient strength to stand against all the listed loads. We have selected the existing frame of I.C. engine bike as it fulfils all the criterion and is designed

by experts for better safety and efficiency. Some modifications are made in order to accommodate the motor, batteries and brakes.

4.2 Drive Assembly

The rear tyre is to be driven with a chain and sprocket mechanism. In order to achieve this and hold the wheel in position, a swing arm was required. Hence we have chosen the swing arm of another common production bike. We have attached the brake drum and sprocket hub of other bike to each other so that the sprocket can be mounted on the wheel. A Chain is used to transmit force from front sprocket on the motor shaft to the rear wheel sprocket. Bearings (6001-S) were press fitted in the drum with the help of sleeve and bushes to accommodate the rear axle.

4.3 Batteries

To run the motor at full speed condition and to cover maximum range in at the designated speed motor requires a consistent power supply which is easily available and batteries can be reused. We have selected Silicone gel E- bike batteries to provide the power. These batteries are made for dynamic load as opposed to static load of standard VRLA batteries. The voltage provided should be equal to or more than the input voltage of motor i.e. 48V DC. We have selected 4 batteries of 12V and connected them in series to achieve the required voltage. The batteries are easily rechargeable and maintenance free.

Selected batteries have following specification

- Current rating : 28 Ah
- Voltage : 12V
- No. of batteries : 4
- Combination of batteries : Series
- Combined Voltage : 48V
- C rating : 5

4.4 Motor

To drive the vehicle at a speed of 50 kmph and provide a rated torque about 6.2 N-m a motor having capacity up to 1500 watt is sufficient. But we have selected motor of 2000 watt. We have taken a Brushless DC motor of custom manufacturing. The motor used in this project is BLDC motor and can be custom made as per the requirement or is available in the market. Cost of BLDC motor is below 8000 making it suitable for low cost application. The front sprocket is attached to the shaft of the motor with the help of a mild steel pulley machined as per the requirement. Motor was mounted on the swing arm with the help of a base plate.

Specification of selected motor -

- Type : Brushless DC Motor
- Power :2000 Watt

4.5 Motor Controller

Motor is supplied the current from batteries corresponding to the input from throttle. Controller takes input from throttle connector and varies the power supply to the motor. We selected controller suitable to our motor as per the current needs. It has the following specification

- Operating current : 60 A
- Operating Voltage : 48 V DC
- Phase angle : 120 degrees

4.6 Battery Charger

Battery gets drained after running a distance of 30-40 km and it does require recharge. For charging a charger is required. It converts AC current into DC. It consist of step down transformer, rectifier and filtering circuit to supply constant voltage.
Specification of selected charger

- Input voltage: 170-300V
- Input current: 1A max
- Output voltage: DC 48 V
- Output current: 3.5 A

5. COST ESTIMATION

Component	Cost
Frame	0
BLDC Motor	7500
Controller	5500
Battery set	12000
Battery charger	4500
Accessories	1900
Chain- sprocket set	650
Fabrication	3000
Other	2000
Total	37500

6. Results and Discussion

- Top speed of 50 Kmph was achieved on a level road.
- The range of bike is 30-40 Km after full charge.
- A BMS and lithium Ion battery can be added for more range and reduced weight.
- Bike was tested successfully for light daily use.
- Battery charging takes around 8 hours for full charge.

7. CONCLUSIONS

[1] The objective of the study was to design a customisable vehicle which will be affordable to everyone.
[2] We mitigated problems faced by existing model.
[3] As compared to IC engine vehicle, running cost of our E-bike is almost $1/10^{th}$.
[4] E-bike has been fabricated and tested successfully. Different parameters like running range, cost per kilometre, Discharge time of battery has been measured with actual running condition and it delivered better results.

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BIOGRAPHIES