70(10A): 331-335; 2022. DOI: 10.18311/jmmf/2022/32777

Print ISSN : 0022-2755
Journal of Mines, Metals and Fuels
Contents available at: www.informaticsjournals.com/index.php/jmmf

Development of Petro-Electric Vehicle

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Abstract

The exhaust of fossil fuels has made to think on alternative energy utilization like electrical energy. The automobile sector is one where one can replace the requirement of fossil fuels by electrical energy. Almost all researchers and developers are looking for design of new electric bike, without making an attempt to make modification in existing gasoline vehicle. The increase in price of petrol which cannot be offered by many of Indians particularly the farmers. The majority of farmers use TVS XL moped scooter for their day today work. In this paper an attempt is made to modify the existing TVS XL moped gasoline scooter by replacing the internal combustion engine with an electric motor. In this vehicle, the electric motor will supply the power to drive shaft through chain drive. The design and implementation of power transmission through chain drive when compared to hub mounted electric motor is more economical. The main reason for converting gasoline engine into electric drive reduces the financial burden on farmers, reduces the pollution and saves the material wastage (scarp).

Keywords: *Battery, DC Motor, Electric Vehicle, Sprocket.*

1.0 Introduction

The cost of buying new electric bike is high where it is difficult to offer by farmers. Though the electric bikes are environment friendly and less operating cost, farmers are very reluctant to buy new electric bike because of high initial investment [1-3]. Hence an attempt has been made to covert the existing TVS XL moped gasoline scooter in to electric scooter by replacing the internal combustion engine with an electric motor. The other major modification is made in transmission of power from electric motor to rear wheel. The remaining components or structure of scoter remains unaltered. This attempt aims, with very minimum cost of TVS XL moped gasoline scoter can be converted into electric scoter. To reduce pollution and avid wastage of material the one of the beat method is to convert the existing petrol vehicle into electric vehicle [4]. This approach also enable to increase the product life cycle of moped. As a new petrol vehicle initially the performance is good with less emission and after a few years the performance of vehicle will be reduced with more emission. Instead of making scrap vehicle as per the pollution standard, the same vehicle can be converted into electric vehicle. This enable to improve the economy of the company and country.

Every day the oil prices go on increasing due to less availability of oil, more number of people are depending on private and own vehicles instead of using public transport. Eventually there will be a non-availability of oil resources after 50 years. This demands the search of alternate energy sources particularly for automobile sector [5, 6]. The charging of batteries can be done by using electric power from grid, solar panel and other non-conventional energy sources [7]. Use of commercially available electric bike is limited due to more time for charging battery when compared to gasoline filling time, limited range of travel distance, speed and high initial investment on purchasing of new electric bike [8].

The recent development in li-ion and BLDC motors motivate to design of electric bikes. Indian government is planned to develop infrastructure required for electric vehicles

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and banning of IC engine vehicles by another 10 years [9]. Hence there will be a lot of material wastes and which could increase the pollution rate. These wastes will accumulate as the time progresses and causes a major pollution to country. Reuse of existing material improves the economy of the country and also gives new look to used vehicles [10]. Almost all the electric scooters exhibit low performance under longer distance travel. The model developed consists of a BLDC motor with controller, battery in addition to existing part of scooter except IC engine. Almost all the researchers made attempts to convert the conventional bike into electric bike. Hence an attempt has been made to convert TVS XL moped gasoline scoter into electric scooter with very minimum modification and with minimum cost which ordinary person (farmer) can offer. Also aim to minimize the waste of material in the era of switching over from petrol vehicle to electric vehicle.

2.0 Vehicle Components

The TVS XL moped gasoline scooter is chosen to convert into electric scooter. The IC engine is removed and provision has been to electric BLDC motor and other accessories with making any changes in scoter structure. Provision also has been made to replace electric motor back with IC engine. The main electric and electronics components incorporated are BLDC motor, battery, battery managing system, DC controller, accelerator, ignition switch and charging cable. The BLDC motor with power rating of 48V DC and 750 W with a rated speed of 517 rpm is used. Nickel-metal hydride batteries of 3.6V, 5Ah and 13S 2P number of series and parallel connection integrated with battery management systems is used. The battery management system control circuit monitor and adjust the charging and discharge of batteries. The DC controller has been used to control the speed and direction of rotation motor, also optimizes the energy conversation.

3. Design of Components

3.1 Torque Generated by BLDC Motor

The specifications of motor are as follows:
Speed of Motor (N) = 517 rpm, Volt (V) = 48V and
Power (P) = 750 W
Power = I * V
Therefore Current (I) = 750/48 = 15.6 A
Torque of motor, $T = (P \times 60)/(2\pi N)$
$T = (750 \times 60)/(2\pi \times 517)$
T = 13.85 N-m
Therefore the torque at the motor, T = 13.85 N-m

3.2 Power Required to Propels the Vehicle

Total Weight (W) = Vehicle weight + Passenger's weight
W = 80 + 100
W =180 Kgf
Total resistance (R) = Rolling resistance + Air resistance + Gradient resistance
R= KrW + KaAV2 + W Sin θ
Here, Kr = Co-efficient of Rolling resistance = 0.018
Ka = Co-efficient of Air resistance = 0.0028
V = Velocity of the Vehicle = 40 m/s
A = Projected frontal area of vehicle = 0.571m^2
R = (0.018*180) + (0.0028*0.571*25^2) + (180*Sin (0)
R = 4.22Kgf
R = 4.22*9.81 = 41.39 N
Power = (41.39*8.33)/0.9
P = 383.08W

3.3 Battery Selection

To run the electric bike with 48v and 750W BLDC motor, current consumed by motor to run
Power = voltage × current
750 = 48 × current
Current =15.625 Amps (Theoretical value)
Watt hour of the battery to run the 750w motor for 1 hour
Assume, efficiency = 99% for battery
(750/0.99) = 757.5Wh
Convert watt hour of battery into ampere hour of battery
Power = voltage *current
Also, watt hour = voltage*Ah
757.5 = 48*Ah
Amp hour = 15.46 Ah
Therefore, to run the 750w motor for 1 hour, 48V & 15Ah battery is needed.

3.4 Power Usage for Charging

Charger specification, power = V * I = 48V * 3Ah = 144 W.
Battery specification, power = V * I = 48V*10Ah=480 W
Charging time = 480/144 = 3.3 hours

3.5 Bearing Hub

A bearing hub is designed to counter balance the weight of motor and it is mounted on vehicle as shown in Fig.1. Mild steel was used for its easy workability inside which two 17-35-10 bearing secured with circlip.

3.6 Mounting of Motor and Battery Box

The motor is mounted on shaft where the engine was placed and the racks were welded. The battery box that was

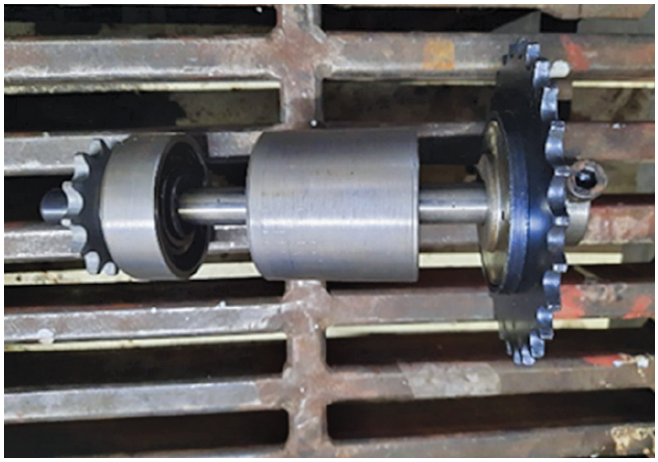

Figure 1: Example bearing hub

Figure 2: Motor assembly and battery box

manufactured was mounted and clamped onto to the frame and it is perfectly aligned. The motor assembly and battery box is shown in Fig.2.

3.7 Design of Drive Train

The transmission from the motor was not given directly to the rear wheel due to the offset of the motor leading to imbalance of the vehicle. The transmission was transferred to the rear through a hub bearing having two sprockets on the either ends and then transferred to the rear wheel. The line diagram of drive system is shown in Fig.3.

The multiple test runs were conducted with sprocket having the following teeth and optimum speed is obtained for a sprocket-4 containing 38 teeth. The number of teeth on each sprocket is as shown Table 1.

Table 1: Number of teeth on sprocket

Sprocket Number	No. of Teeth
1st	25
2nd	28
3rd	25
4th	38

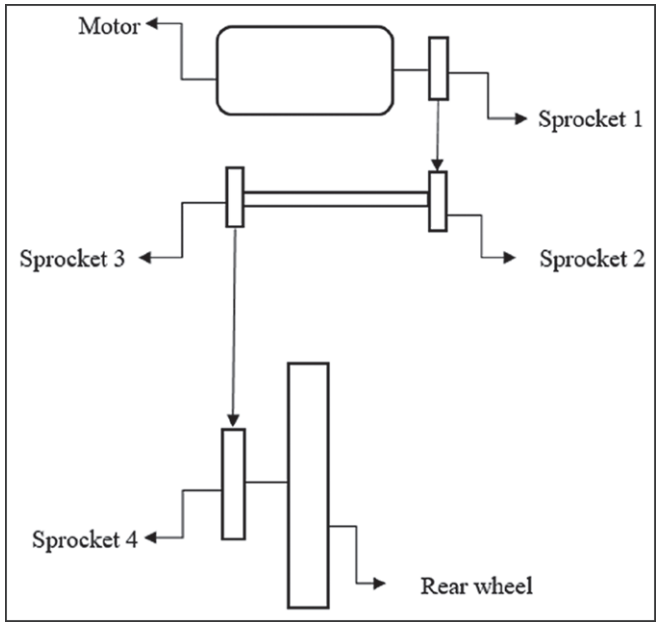

Figure 3: Line diagram of drive train

RPM from the motor = 517 rpm
RPM of rear wheel containing 4th sprocket having teeth of 38 = 320 rpm
Speed of vehicle = (circumference of wheel × RPM of motor)/60
Speed of vehicle= (1.672 × 320)/60 = 8.92 m/s = 32112 m/hr. = 32.11 km/hr.

4.0 Working

The project work proposes a solution by modifying of existing scooters into electric which require a motor and battery.

Here the motor used is a 750 watt, brushless DC motor which runs on 48volts battery which discharges 16Ah of current to run for an hour at nominal speed. The drive train works from the motor to the centre guiding axle which is then connected to the real driven wheel. This design was chosen to avoid the offsetting of the motor which could have led to

imbalance of the vehicle while riding. The battery connection is established with the controller placed with the battery inside the battery box. The controller is connected to the motor through three phase wire and one hall sensor wire. The headlight, throttle and the key has a separate connection established with the controller. As the throttle is given based on the angle of rotation the speed of the motor is varied by the controller and in turn the speed of the vehicle. Line diagram of electrical vehicle wiring is shown in Fig.4

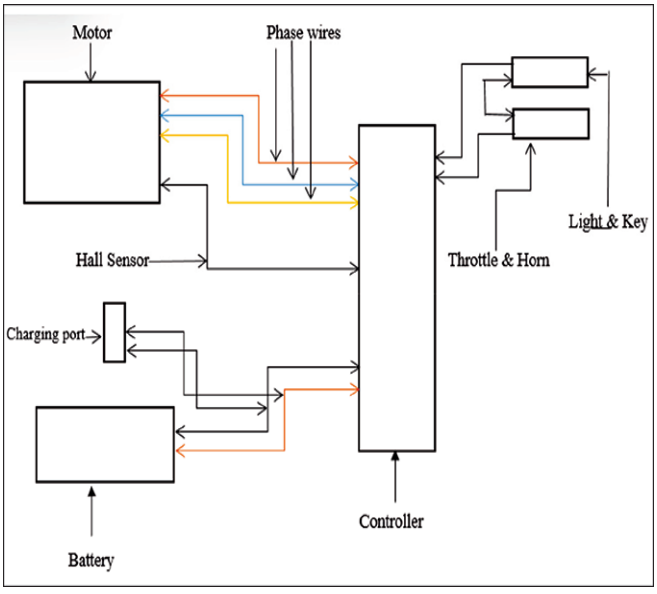

Figure 4: Line Diagram of Electrical Vehicle Wiring

5. Results and Discussion

The various results obtained using theoretical calculations and the performance of designed vehicle is compared by attaching the sprockets contain different number of teeth which made noticeable changes. The practical values obtained were slightly lower than the theoretical considering the losses in the drive train and external resistances. The parameter chosen for comparison of electric bike with conventional bike is shown in Table 2.

Table 2: Comparisons of vehicles

	Specifications	Conventional bike	Electric bike
1	Fuel source	Most of them Petroleum based fuel	Electricity Through Battery Pack (DC)
2	Engine	Internal combustion engine (ICE)	Electric Motor(s)
3	Fuel Efficiency	Cars, scooters and motorcycles being typically 24 %, 9 % and 12 % respectively	Depends on Battery Range (Comparatively Less)
4	Emission / Pollution Levels	Higher	Lower Compared to ICE
5	Price Range of Vehicle	Lower (compared to electric)	High
6	Charging	Not needed	Needed

Table 3: Cost analysis per unit distance

Sl. No	Scooter	Price[1]	Distance(KM)	Price per unitdistance [1]
1.	Gasoline scoter	110	40	2.75
2.	Electric scoter	5	30	0.16

Table 4: Test Run Results

Trial No	Theoretical		Practical	
	RPM	Speed in km/h	RPM	Speed in km/h
1	130	12	100	10
2	250	23	221	22
3	320	32	300	30

The Table 3 shows the cost analysis per unit distance comparison between gasoline and electric scoter under normal conditions. The result indicates that the electric bike more economical than petrol bike.

The three test runs were conducted with different sprockets to achieve higher speed and the results were tabulated in Table 4. After the final test run it was concluded that the vehicle runs at a speed of 30km/h having 300 rpm at the rear wheel.

6.0 Conclusion

In this work a systematic approach has been made to modify the petrol driven scooter into electric driven scooter. The scooter used for the modification is TVS XL 50, which is most popular scooter used by many of the farmers for their day to day transportation and carry the luggage like fertilizer, milk and feed required for domestic animals. Many of farmers not possible offered to a new electric scooter. Instead of making existing scooter as a scrap and purchasing new electric scooter in the era of electric power utilization, one can modify the existing scoter with minimum cost. This method of modifying of scooter has advantages like saving of material, less cost for a buyer and gives employability locally. The modification is done by just replacing IC engine by electric motor with additional important accessories such as battery, bearing hub and chain drive. The modified scooter performance is on far with petrol scooter

7.0 References

1. Ali Eydgahi (2011). "Converting an internal combustion engine vehicle to an electric vehicle." *American Society for Engineering Education*.
2. Varadmurti Patil and Shubham Kurunde. (2018). "A overall review on electric vehicle and its conversion perspective." *International Journal of Advances in Science Engineering and Technology*, 6 (4), 43-47.
3. Atul Kaushik. (2022). "Conversion of petrol bike to an electric bike,"*International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences,* 10 (2), 125-132.
4. Kapil Shrivastava, Ram Bansal, Himanshu Jain, Nimil Doshi, Niraj Soni and Nikita Soni. (2020): "Conversion of conventional vehicle into an electric vehicle." *Advances and Applications in Mathematical Sciences,* 20 (1), 15-24.
5. Delfim Pedrosa, Vítor Monteiro, Henrique Gonçalves, Júlio S. Martins, and João L. Afonso. (2014): "A case study on the conversion of an internal combustion engine vehicle into an electric vehicle." IEEE Vehicle Power and Propulsion Conference, 1-5.
6. K. S. Sathish Kumar, Franklin Xavier. A, Avinash. R, Muthupitchiya. P and Jerrin K Abraham. (2019): "Conversion of an IC Engine vehicle in to electric vehicle." *International Journal of Engineering Research & Technology*, 7(6),1-7.
7. Akash Anil Vaidya, Prof.T.S.Sargar and Saket P. Joshi. (2019): "Conversion of IC engine bike into electric motor bike." *Journal of Emerging Technologies and Innovative Research*, 6 (4), 486-489.
8. S.Vasanthaseelan, D.S. Dharun, S.Sreerag and R.Gokul. (2019): "Conversion of IC engine vehicle to electric vehicle." *International Research Journal of Engineering and Technology*, 6 (3), 3325-3330.
9. Haroon Rayyan Harris, Ajay G Dev, Joel Jose, Ganesh Jithamanyu D V, Vishnu Sankar and Jibin Noble. (2021): "Conversion of two-stroke vehicle to an electric vehicle." *Journal of Physics:* Conference Series.
10. Harshal Chokhandre, Suraj Wanjari, Sajan Meshram, Yashodip Mendhe, Sakshi Kadam, Tushar Patel, and Mrs. R.S. Tupkar. (2022): "The development for conversion of conventional fueled vehicle into hybrid vehicle." *International Research Journal of Modernization in Engineering Technology and Science,* 4 (5), 2961-2966.