INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 3)
Available online at: www.ijariit.com

Self power generating electric bike

Mayur Balkrishna Patil
pmayur581997@gmail.com
Dr. D Y Patil Pratisthans College of Engineering, Kolhapur, Maharashtra

Suraj D. Patil
surajpatil.production@gmail.com
Dr. D Y Patil Pratisthans College of Engineering, Kolhapur, Maharashtra

Rohit S. Sankpal
rohitsankpal50@gmail.com
Dr. D Y Patil Pratisthans College of Engineering, Kolhapur, Maharashtra

Adarsh P. Patil
adarsh.ppatil1996@gmail.com
Dr. D Y Patil Pratisthans College of Engineering, Kolhapur, Maharashtra

Omkar A. Rajput
omkarrajput8994@gmail.com
Dr. D Y Patil Pratisthans College of Engineering, Kolhapur, Maharashtra

Suyog S. Shinde
suyogshinde878@gmail.com
Dr. D Y Patil Pratisthans College of Engineering, Kolhapur, Maharashtra

ABSTRACT

Now day's bike or vehicle is very important our fast life for travelling and this is also play very important role in growth of economy but main drawback of this bike and vehicle is produce pollution in environment because of burning fuel. For this reason, increases global warming and also storage of fuel is limited. Due to that now day's need of eco-friendly technology for travelling. E-bike (electrical bicycle) this is nothing but one example of eco-friendly technology but this technology having some drawback to overcome the drawback of e-bike we have been design self-power generating electrical bike. This design overcomes all the drawback of e bike. Self-power generating electrical bike is nothing but e-bike that generate its own power supply by using some arrangement.

Keywords— *Alternator, Battery, Motor, DC Booster*

1. INTRODUCTION

Global warming is becoming major problems in the current scenario. Therefore, people try to move towards clean energy. Transportation is one of the source of pollution or global warming because bike or any type of vehicle work on fuel (petrol, diesel) it burn and produce harmful gases in air due to that pollution is increases and also this source of energy is limited therefore today's need to move towards clean source of energy for transportation that free from pollution.

The e-bike is drive with the help of electric power. In this bike energy generate by using alternator and this energy is stored in the storage battery. The stored energy can be used for running the bike. Electrical bicycle can be used for a variety of purpose.

2. PROBLEM DEFINITION

With increasing in air pollution and scarcity of fuels. An electric bike is in great demand but it is not used by the people because of lack of awareness. Thus, the purpose of this study is to consumer goes towards electric bike. Electric bike is eco-friendly with environment.

Now also we know that the electric bike required maximum 3-4 hours for 100% charging of battery. In that 100% battery (20 Ah battery), e-bike moves at least 60 to 70 km with speed of 35-40 km/hr. Hence, after every 70km we must recharge battery again. It takes also 3-4 hours for charging. Hence, we have arranged the alternator with e-bike at rear wheel which generate power supply on the rotation of wheel.

3. NEED AND OBJECTIVES

3.1 Need

The main reason to design the electric bike is to overcome the problem with the pollution and with the economy. Future E bike is the best technical application as a solution for the better world and upcoming generation. The E bike is a battery-operated vehicle that is very economical with low maintenance cost and less pollution. E bikes are an attractive alternative to both conventional bicycles and traditional automobiles, providing an environmentally friendly, fun, efficient and convenient way to travel.

Now days all the vehicle work on fuel but storage of fuel is imitated that means when the storage of fuel is totally finish that time transportation is totally stop. There for today's need is self-power generating electrical bike that bike generate owner power and work on self-power without effect on working of operation and this is not having any type of external energy it is free from pollution.

3.2 Objectives

- It is clearly seen that the electrical bike gives a clean and more economical solution to the crisis.
- To suggest improvements in existing processes for energy conversation.
- To assess the annual saving of gasoline and reduction of CO2 emission for the span of next 10 years.
- It is non pollutive which is eco-friendly with environment.

4. HYBRID SYSTEM

4.1 Overview

This section of the paper deals with the mechanical design of the system and the various parts used in the system integration. The power transmission system consists of the motor, the chain sprockets, Alternator, DC booster and the rear wheel. However, before we could select these components, we performed some basic calculations relating energy transfer through the system. Primarily we focused on the current requirements of the system, and a number of torque-speed relationships. Both the acceleration on flat ground and hill climbing ability of the system depend on how much torque can be delivered by the various system components. Before we could size the batteries, we needed to estimate when the motor would demand the most current and the duration that it would draw its peak current. These situations would be at start up (acceleration) and when climbing a gradient. The main components affected by the following calculations are the motor and the battery.

4.2. List of Component

4.2.1 BLDC Motor: Brushless DC (BLDC) motors are synchronous motors consisting of armature windings on the stator permanent and magnets on the rotor. The stator of a BLDC motor consists of stacked steel laminations with windings placed in the slots and these stator winding can be arranged in two patterns i.e. a star pattern or delta pattern. The major difference between the two patterns is that the star pattern gives high torque at low RPM and the delta pattern gives low torque at low RPM. There are many advantages of BLDC motor such as better speed versus torque characteristics, high dynamic response, high efficiency, long operating life, noiseless operation, higher speed ranges.

Fig. 1: BLDC Motor

Its specifications are as follows:

- Current Rating: 13.5 amp
- Voltage Rating: 48 Volts
- Cooling: Air – cooled
- Bearing: Single row ball bearing

4.2.2 Battery: A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices. The battery also acts as a condenser in a way that it stores the electric energy produced by the generator due to electrochemical transformation and supply it on demand.

Fig. 2: Battery

Battery is also known as an accumulator of electric charge. This happens usually while starting the system. We use four batteries in series to get 48v. Its specifications are as follows:

- Battery type: Lead acid battery
- Battery voltage: 12 Volt
- Capacity: 24AH

4.2.3 Controller: The electric bike controller is one of the main parts of an electric bike, it is the brain of the e-bike, controlling the motor's speed, start, and stop. It is connected to all the other electronic parts such as the battery, motor, and the throttle(accelerator), display(speedometer), PAS or other speed sensors if exist.

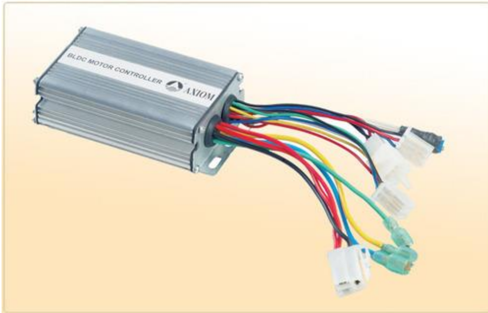

Fig. 3: Controller

Its specification is:

- Rate voltage: DC 48volt
- Rate power: 750 Watt
- Rated current: 13.5 Amp

4.2.4 Twist throttle: A twist throttle is a handle that can be twisted to operate and control the motor. It is commonly connected at the right handle bar of motorcycle, but sometimes it can be connected elsewhere. When the throttle is engaged the motor provides power and propels you and the bike forward. A throttle allows you to pedal **or** just kick back and enjoy a "free" ride.

Fig. 4: Twist throttle

4.2.5 Frame: The Frame is made up of M.S. along with some additional light weight components. The frame is designed to sustain the weight of the person driving the unit, the weight of load to be conveyed and also to hold the accessories like motor. Also it should be design to bear and overcome the stresses which may arise able to due to different driving and braking torques and impact loading across the obstacles. It is drilled and tapped enough to hold the support plates.

Fig. 5: Frame

4.2.6 Alternator: An alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current. The power for the electrical system of a modern vehicle gets produced from an alternator In previous days, we used DC generators or dynamos for this purpose, but after the development of alternator, we replaced the DC dynamos by more robust and lightweight alternator.

Fig. 6: Alternator

Although the electrical system of motor vehicles requires direct current, still an alternator along with diode rectifier instead of a DC generator is a better choice as the complicated commutation is absent in alternator. Its specifications are as follows:

- Output voltage 12 volt
- Output current: 60 amp
- Maximum speed: 7000 rpm

4.2.7 DC Booster: A boost converter is one of the simplest types of switch mode converter**.** As the name suggests, it takes an input voltage and boosts or increases it. All it consists of is an inductor, a semiconductor switch, a diode and a capacitor. The basic DC to DC converter will take the current and pass it through a "switching element". This turns the signal into a square wave, which is actually AC. The wave then passes through another filter, which turns it back into a DC signal of the appropriate voltage necessary.

Fig. 7: DC booster

Its specification are:

- Input voltage: 8.5V-50V
- Output voltage: 10V-60V
- Output current: 0.2A-12A

4.2.8 Chain: A bicycle chain is a roller chain that transfers power from the pedals to the drive-wheel of a bicycle, thus propelling it. It is the more common type of chain drive which is used for transmission of mechanical power to long lasting & better way of rotatory motion from one gear to another it is derived by a tooth head wheel called a sprocket it is simple, reliable and efficient.

Fig. 8: Chain

4.2.9 Belt: Belt are a type of frictional material used for transmitting powers from one shaft to another by means of pulleys which rotate at the same speed or at the different speed. It is passed over the pulley, the mechanical power or rotary motion is transmitted from the driving pulley to the driven pulley because of the frictional grip that exists between the belt and the pulley surface. Here drive is given from big pulley which is fitted at rear wheel of bike to the smaller pulley which is fitted on alternator.

Fig. 9: Belt

4.2.10 Sprocket: A sprocket or sprocket-wheel is a profiled wheel with teeth, or cogs, that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. Sprockets are used in bicycles, motorcycle, cars and other machinery either to transmit rotary motion between two shafts where gears are unsuitable.

Fig. 10: Sprocket

4.2.11 Pulley: A pulley is a wheel that carries a flexible rope, cord, cable, chain, or belt on its rim. Pulleys are used singly or in combination to transmit energy and motion. In belt drive, pulleys are affixed to shafts at their axes, and power is transmitted between the shafts by means of endless belts running over the pulleys.

Fig. 11: Pulley

5. MATHEMATICAL CALCULATIONS

5.1 Current required for motor

Power of motor = 750 watt

Voltage required = 48v dc

Current required = ?

You know that,

Power = Current × Voltage

$$\therefore 750 = \text{Current} \times 48$$

$$\therefore \frac{750}{48} = \text{Current}$$

$$\therefore 15.625 = \text{Current}$$

$$\boxed{\therefore \textbf{Current} = \textbf{15.625 amp}}$$

5.2 Torque of the motor

We know that,

$$\text{Power} = \frac{2\pi NT}{60}$$

∵ N = Speed of motor = 3000 rpm, Power = 750-Watt, Torque =?

$$\therefore \textbf{Power} = \frac{\mathbf{2\pi NT}}{\mathbf{60}}$$

$$\therefore 750 = \frac{2 \times \pi \times 3000 \times T}{60}$$

$$\therefore T = \frac{750 \times 60}{2 \times \pi \times 3000}$$

∴ T = 2.38

∴ Torque = 2.38 Nm

5.3 Speed ratio of sprockets

Number of teeth on driver sprocket = 12

Number of teeth on driven sprocket = 42

$$\therefore \textbf{Speed ratio} = \frac{\textbf{Number of teeth on driver}}{\textbf{Number of teeth on driven}}$$

$$\therefore \textbf{Speed ratio} = \frac{12}{42}$$

∴ Speed ratio = $\frac{1}{3}$

5.4 Time required to charge the battery

5.4.1 At zero load condition

$$\therefore \textbf{Charging time of battery} = \frac{\textbf{Total battery ampere hour rating}}{\textbf{Total charging current}}$$

Here we use 27 Ah battery

∴ Battery ampere hour rating = 27 Ah

Considering battery losses

∴ Battery losses = 40 % of battery rating

$$\therefore \text{Battery losses} = \frac{40}{100} \times 27$$

∴ Battery losses = 10.8 ah

∴ Total battery ampere hour rating = Battery ampere + Battery Hour rating losses = 27 + 10.8

∴ Total battery ampere hour rating = 37.8 Ah

Current required for charging = 25 % of battery ampere hour rating

$$= \frac{25}{100} \times 27$$

Current required for charging = 6.75 amp

Considering losses

Hence add +1or 2

∴ Total charging current = current required for charging + losses

= 6.75 + 2

= 8.75

∴ Total charging current = 9 amp

$$\therefore \textbf{Charging time of battery} = \frac{\textbf{Total battery ampere hour rating}}{\textbf{Total charging current}}$$

$$= \frac{37.8}{9}$$

∴ Charging time of battery = 4.2 hours

5.4.2 At loading conditions (When connected to motor)

When the battery is connected to the load (running motor) while in charging then the required charging current is the addition of load and the charging current required for the battery.

∴ Total charging current = load + charging current required for battery

= 15.625 + 9

∴ Total charging current = 24.625

$$\therefore \textbf{Charging time of battery} = \frac{\textbf{Total battery ampere hour rating}}{\textbf{Total charging current}}$$

$$= \frac{37.8}{24.625}$$

∴ Charging time of battery = 1.54 hours

5.5 Battery discharging time

$$\therefore \textbf{Discharged time} = \frac{\textbf{Battery ampere hour rating}}{\textbf{Load (amp)}}$$

Here battery hour rating = 27

$$\therefore \text{Discharged time} = \frac{\text{Battery ampere hour rating}}{\text{Load (amp)}}$$

$$= \frac{27}{15.625}$$

∴ Discharged time = 1.73 hours

5.6 Cost of battery charging

$$\therefore \textbf{Cost of electricity} = \frac{\textbf{capacity} \times \textbf{price per kwh}}{\mathbf{1000}}$$

$$= \frac{\textbf{V x Ah} \times \textbf{price per kwh}}{\mathbf{1000}}$$

$$= \frac{37.8 \times 48 \times 9}{1000}$$

(∵ Price of kwh taken from Jan 2020)

∴ Cost of electricity = 16.33 rupees

∴ Cost of battery charging = 17 Rupees

5.7 Power required for motor at various weight

Here,

Weight of the vehicle = 116 kg

Without engine = 86 kg

With 2 person

Total weight carried by vehicle = 86 + 150 = 236 kg

Hence calculate power required to move 236 kg at 30km/h

Mass of vehicle= **236kg**

(Assuming **g= 9.81m/s²**)

Weight of vehicle= **2315.16N**

Now this will act along the center of gravity of wheel and considering wheel as cylinder with **r= 0.2662m**, **L= 0.126cm**

Using parallel axis theorem,

Moment of inertia along diameter at wheel surface

$$\mathbf{I} = \frac{1}{4}\,\mathbf{x\, mr^2} + \frac{1}{12}\,\mathbf{x\, mL^2} + \mathbf{mr^2}$$

$$= \frac{236 \text{ x } 0.2662 \text{ x } 0.2662}{4} + \frac{236 \text{ x } 0.126 \text{ x } 0.126}{12} + (236 \text{ x } 0.2662 \text{ x } 0.2662)$$

∴ I = 21.2 kg.m²

$$\text{Angular velocity} = \frac{\text{speed fo vehicle in m/s}}{\text{radius of wheel}}$$

$$= \frac{30\ x\ \frac{1000}{3600}}{0.2662}$$

∴ Angular velocity = 31.30 rad/sec

It takes **17sec** to reach **30km/hr**

Angular acceleration (α)

$$\alpha = \frac{\text{Change in angular velocity}}{\text{time}} = \frac{31.30}{15}$$

$$\therefore \boldsymbol{\alpha = 2.087\ rad/sec^2}$$

$$\text{Torque} = I \times \alpha\ s = 21.2 \times 2.087$$

$$\therefore \textbf{Torque = 44.24 Nm}$$

Speed of revolution

$$N = \frac{60 \times I}{2\pi} = \frac{60 \times 21.2}{2\pi}$$

$$\therefore \textbf{N = 202.45 rpm}$$

$$\therefore \textbf{Power} = \frac{2 \times \pi \times N \times T}{60} = \frac{2 \times \pi \times 202.45 \times 44.24}{60}$$

$$\therefore \textbf{Power = 937.91 watt}$$

∴ Power required for motor at 236 kg at 30km/h is equal to 937.91 watt

5.8 Current required for motor at weight 236 kg at 30km/h

You know that,

$$\text{Power} = \frac{2 \times \pi \times N \times T}{60} \qquad \text{(i)}$$

Also

You know that,

$$\text{Power} = \text{current} \times \text{voltage} \qquad \text{(ii)}$$

Equating equation (i) and (ii)

$$\therefore \frac{2 \times \pi \times N \times T}{60} = \text{current} \times \text{voltage}$$

$$937.91 = \text{current} \times 48$$

$$\text{current} = \frac{937.91}{48}$$

$$\therefore \textbf{Current = 19.54 amp}$$

∴ Current required for motor at weight 236 kg at 30km/h = 20 amp

6. CONSTRUCTION

Figure 12 shows the block diagram of the self-generating electric bike. It consists of four basic elements like alternator, booster, battery, controller & motor etc. In left hand side charging element are placed which generated the electric charge for the battery on the rotation of wheel. This element are alternator and booster. Alternator generate the charge on the rotation of wheel. In right hand side discharging element are placed which received charge from battery for working. Here battery is connected to the controller. Controller is heart of E-bike which controlled operation of bike. Headlight, throttle, and motor is connected to the controller. Battery is also connected to the booster which receives the charge from the alternator. Alternator rotate on the rotation of rear wheel through belt drive. Pulley is attached to the rear wheel which transmit power to the alternator.

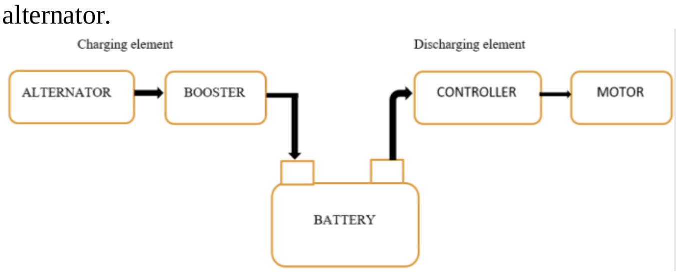

Fig. 12: Block diagram of self-generating electric bike

7. WORKING

Working of e bike explained in the following terms:

7.1 Power supply from the battery to the motor and the accessories

When the key is plugged into the vehicle, vehicle is start but that time power is not transfer to the motor. Key only start supplies current from the battery to the controller. Controller operate on the 48DC voltage. It controls all the process inside the bike. Hence it is called CPU of e-bike.

When the current is goes inside the controller, controller transfer this current to the accessories which are connected to the controller like headlight, throttle etc. Throttle is a control of motor. It is a one type of voltage regulator which control the voltage. Speed of the vehicle is control by using this throttle.

7.2 Power supply from the Alternator to the DC booster

The alternator is comprised of a voltage regulator and three main components: The stator, rotor, and diode. When the battery initially powers the car, belt of pulley spins the pulley of the alternator, causing the rotor inside the alternator to spin very quickly. This rotor, which is basically a magnet or group of magnets, is situated inside a nest of copper wires, which are called the stator.

The process whereby electricity is generated by spinning magnets at incredibly fast speeds along a set of copper wires is called electromagnetism. The electricity harnessed this way is conducted through the copper wires to a diode, which changes the electricity from AC to DC, the current that the car battery uses. The next step happens within the voltage regulator a built-in component on modern alternators which is basically a gatekeeper that will shut off the flow of power to the battery if the voltage goes above a certain level, usually 14 and a half volts, which keeps the battery from getting overcharged and burning out.

After this dc power is supplied to the booster to step up the voltage because alternator generated less voltage which is required to charge the battery.

7.3 Power supply from the booster to the battery

In the ON part, the switch is closed as we can see in the figure where the diode is open because the cathode voltage is higher than the anode. The key principle that drives the boost converter is the tendency of an inductor to resist changes in current by creating and destroying a magnetic field. In a boost converter, the output voltage is always higher than the input voltage. When the switch is closed, current flows through the inductor in clockwise direction and the inductor stores some energy by generating a magnetic field. Polarity of the left side of the inductor is positive.

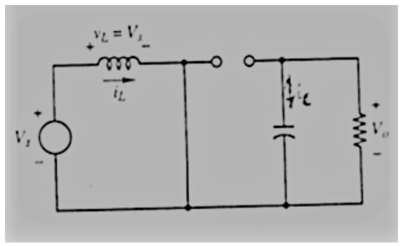

Fig. 13: DC booster close switch

When the switch is opened, current will be reduced as the impedance is higher. The magnetic field previously created will be destroyed to maintain the current towards the load. Thus, the polarity will be reversed (means left side of inductor will be negative now). As a result, two sources will be in series causing a higher voltage to charge the capacitor through the diode D. After this step-up voltage is supplied to the battery.

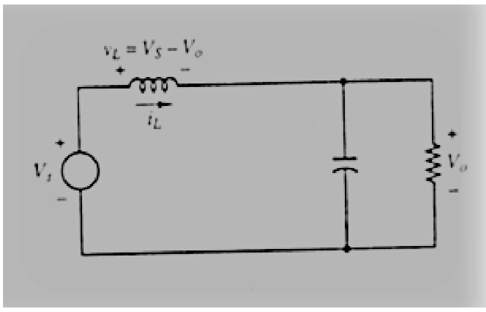

Fig. 14: DC booster opens switch

8. TESTING

This chapter will shortly describe E-bike test procedure. One test involves several partial tests. The four basic tests are presented in this article are as follows:

8.1 Support test

The first test should check the whole E-bike functionality. The motor starts spinning and the support should start. In this test all the function is test like battery power, controller connection, alternator connection, booster connection and wiring connection of the bike.

8.2 Quick stop test

The second test is quick stop test. The support should switch off in very short time after the motor stop.

8.3 Zero load test

In this test only motor is connected to the battery and controller and disconnect the motion through the chain. Motor run up to the battery fully drained. We observed during the test that the motor runs 103.68 minutes at 3000rpm.

8.4 Load test

In this test motor shaft is connected to the rear wheel through chain drive. We observed during the test is when the 1 person sit (up to weight 75kg) on the vehicle then the vehicle runs 93 minutes at 37km/h. And when the 2 persons sitting on the vehicle then the vehicle runs 80 minutes at 35km/h.

8.5 Flat road test

Vehicle moves on flat straight road then we observed that the vehicle easily obtained 40km/h in 13 minutes and runs 95 minutes.

8.6 Ascending road test

We observed during the test is that the vehicle runs at 27km/h with 1 person and with 2 persons at 22km/h.

8.7 Speed test

Maximum 40km/h speed is achieved by the vehicle in flat road surface.

9. CONCLUSION

With the increasing consumption of natural resources of petrol, diesel it is necessary to shift our way towards alternate resources like the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using alternator (electrical energy) and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving crores of foreign currencies. The second most important feature is it is pollution free, eco – friendly and noiseless in operation. For offsetting environmental pollution using of on – board. Electric Bike is the most viable solution. It can be charged with the help of AC adapter if there is an emergency. The Operating cost per/km is very less and with the help of alternator it can lessen up more. Since it has fewer components it can be easily dismantled to small components, thus requiring less maintenance.

10. ACKNOWLEDGMENTS

The sense of contentment and relation that accompanies the successful completion of the project “**Self-generating electric bike**” would be incomplete without mentioning the names of those people who helped us in accomplishing the project. Those people whose constant guidance and encouragement resulted in its realization.

It is the incidence of great pleasure in submitting this project work. We take this opportunity to express our sincere gratitude to **“Prof. S. D. Patil”** for his valuable guidance in this undertaking, without which the project would not have been completed.

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