

## COST EFFECTIVE CONVERSION OF ELECTRIC BIKE

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**ABSTRACT:** Air pollution from motor vehicles and exhaustion of natural resources has become a serious global and environmental hazard. The emission of poisonous gases such as carbon monoxide(CO), nitrogen dioxide(N<sub>2</sub>O), sulphur dioxide(SO<sub>2</sub>) and other hazard gases from two wheelers is a significant contributor to air quality problems which cause severe threats to all living organisms. Due to increase in number of vehicles and limited use of emission control strategies, two wheelers are considered to be a significant source of urban air pollution in most of the Indian cities.

To overcome such harmful effects, the modification of existing fuel operated bike into an electric bike is necessary. The alternate method involves the use of battery as the primary source. The high efficient brushless dc motor uses the supply from the battery to drive the wheels where the controller is used to govern the supply. Though this efficient operation is facilitated.

The conversion of existing bike into hybrid bike is cost effective and predominantly it reduces the number of air pollutants as well as the maintenance cost is much less compared to existing models.

**Keywords:** Electric Bike, Harnessing, Solar energy, Economical, Electricity Nomenclature: P = Power N = revolution per min T = Torque  $\sigma_s$  = Shear stress  $\sigma_t$  = Tensile stress  $\sigma_{ut}$  = Ultimate Tensile Stress  $f_{os}$  = Factor of safety.

### I. INTRODUCTION

Global warming is a major concern all around and to save Mother Earth, there are several policies, promises and pledges. With the ever-increasing emission of greenhouse gases, there is an increased fear of environment pollution with modern technology and innovation, transportation and communication have undergone a paradigm shift. Along with this, we are also step experiencing the negative effects of industrialization in the form of global warming. Under these circumstances, when there are traffic jams, when you need to run an errand at an odd hour of the day, when you need to go to workplace quickly, you stumble and fumble as there are so many vehicles emitting heat and CO<sub>2</sub> polluting the air. With increased number of fossil-fuel dependent vehicles, they not only add to greater level of pollution but are also leading to depletion of fuel resource. It is here that automobile companies felt the need to innovate motorized vehicle that will get charged through electricity and will not be depending on fossil fuels.

This led to expansion of eco-friendly initiatives and many automobile manufacturing companies invested in research and development to bring forth electric bikes that will help people save a few bucks by reducing consumption of already spiralling fuel price,

besides fighting global warming. Most electric bikes are emission-free bikes and this is the USP of the company's manufacturing them in these days of global warming. It will not add to urban pollution. The only thing required is to keep this bike charged with a battery. Electric bike manufacturing is considered as a grass root movement away from fossil fuels.

Definitely, electric bikes are not the only answer to our environment problem, but it definitely will help us to treat environment better. These electric bikes will not make pollution worse and that makes E bikes environmentally safe vehicle. It can be charged with the help of inverter and generator too. In one charge, these electric bikes can go up to 50km and has no tail pipe emissions. It also makes no noise while under operation. The best part of electric vehicles is that they can be run with no registration and license.

In the manufacture and production of electric bikes, the main constraint is the battery in the bumpy roads. Batteries get deteriorated at a fast rate due to excessive current fluctuation. Batteries need frequent replacement and that is the greatest concern for the most Indian companies who manufacture these electric bikes. The replacement cost of the batteries hover around Rs.5000, but otherwise the maintenance cost of electric bikes is almost negligible. There is a growing

market potential of electric bikes in India however, speed might not be the attractive feature of these e-bikes, they will cater you to run the short distances maybe home to office or home to college but these are safer vehicles with benefit of almost no pollution. So instead of kicking a 100cc motorbike, just press the start button of electric bike and vroom your way friendly on the roads.

**Electric Bike**

The Electric bike is a bike which is driven with the help of battery which is coupled to electric motor.

**Main principle:**

It works on the principle that the electromotive force of an A.C. motor which receives electrical energy stored in D.C. battery is converted with the help of D.C. to A.C. converter.

**Working Principle:**

Here for the motivation of prime mover the chemical reaction takes place from which an energizing current is evolved which is responsible for the working. The working principle is sulphuric acid which is separated into columns of H ions and negative SO<sub>4</sub> ions when mixed with water. If the poles of the cell are connected by a load, the flow of the electrons is from negative to positive. A bivalent positive lead is produced from neutral lead when combined with bivalent negative of SO<sub>4</sub> group to form lead sulphate. These results due to scarcity of electrons at negative pole. Through the electron supply a bivalent positive lead is produced at positive pole from quadrivalent positive lead. A combination of SO<sub>4</sub> comes into existence thereby ruling the combination of O<sub>2</sub> which leads to formation of PbSO<sub>4</sub>. The atoms of oxygen and hydrogen from electrolyte are released together to form water thereby decreasing the density of battery acid.

**Operation:**

The form of electric current which flows from battery to D.C. to A.C. converter circuit. By using amplifier circuit, the small A.C. current is amplified again. In order to drive the circuit through the condenser, this amplified current is fed to the stator winding of the A.C. motor. The condenser which is used acts as a storage of electric energy and delivers at the time of requirement. The sprocket wheel installed on motor shaft is driven by the motive power of the electric energy. The rear sprocket wheel is being rotated by the chain drive mechanism on which the other two remaining sprocket wheels are installed. The wheel is driven by the rear

wheel installed on the rear sprocket. Thus, the electric bike is mobilized by using electric power.

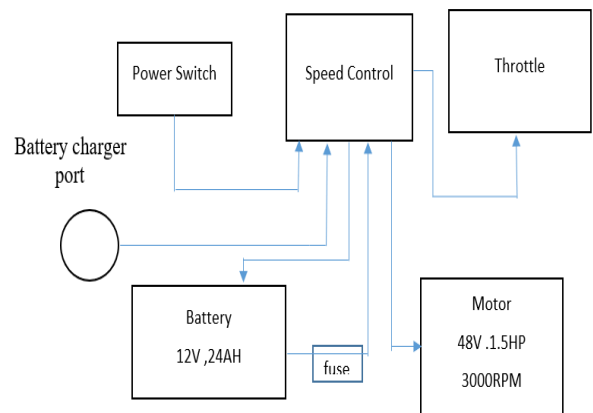


Figure.1.1. Block Diagram of E-Bike

**II. Components of E - Bike**

The Electric bike consists of following components viz, BLDC motor, Frame, Platform, Battery, Drive etc.

**1. DC motor:** The motor is having 250 watts. capacity with maximum 2100 rpm. Its specifications are as follows: Current Rating: 7.5amp Voltage Rating: 48 Volts Cooling: Air - cooled Bearing: Single row ball.



Figure 2.1 E-Bike Motors

**2. 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.

**3. Platform:** The Platform is designed with robust base so that it can hold the load along with the weight of the

driving person uniformly. It is fabricated from Mild Steel at a specific angle in cross section and welded with a sheet of metal of specific thickness. The platform's alignment is kept horizontal irrespective whether it is loaded or unloaded and this is directly bolted and welded to the frame.

**4. Battery:** 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. Battery is also known as an accumulator of electric charge. This happens usually while starting the system.



Figure 2.2 Lead-Acid Battery

**5. Chain Drive:** A Chain is an array of links held together with each other with the help of steel pins. This type of arrangement makes a chain more enduring, long lasting and better way of transmitting rotary motion from one gear to another. The major advantage of chain drive over traditional gear is that, the chain drive can transmit rotary motion with the help of two gears and a chain over a distance whereas in traditional many gears must be arranged in a mesh in order to transmit motion.



Figure 2.3 Chain Drive

**6. Braking System:** For the braking system it is convenient to use braking system used in band brake system which consist of spring-loaded friction- shoe mechanism, which is driven with the help of hand lever.

**7. Sprockets:** The chain with engaging with the sprocket converts rotational power in to rotary power and vice versa. The sprocket looks like a gear but differs in three important ways: Sprockets have many engaging teeth but gears have only one or two. The teeth of a gear touch and slip against each other but there is basically no slippage in case of sprocket the shape of the teeth is different in gears and sprockets.

### 8. Motor Controllers

A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. Every electric motor has to have some sort of controller. The motor controller will have differing features and complexity depending on the task that the motor will be performing. The simplest case is a switch to connect a motor to a power source, such as in small appliances or power tools.

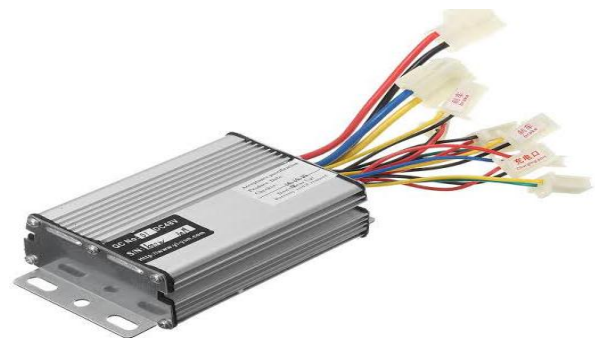


Figure 2.4 Motor Controllers

### 9. Throttle

The main function of throttle is for acceleration and it is also used in different aspects. In both the fuel and electric bikes, the throttle can be used at both the situations we used to have the action to be taken place at the same manner of work on it.

The throttle is used in e-bike for various speed controlling of the motor. The throttle is one of the voltage control method of the motor. By the variation of voltage level, the speed control action to be taken place on it with different levels can be controlled. The benefits of electronic throttle control are largely unnoticed by most drivers because the aim is to make the vehicle power-train characteristics seamlessly consistent irrespective of prevailing conditions, such as engine temperature, altitude, and accessory loads.



Figure 2.5 Throttle

### III. DESIGN AND CONTROL OF LIGHT WEIGHT ELECTRIC VEHICLE

The electric motorcycles (E-bikes) gaining popularity in India due to steady rise in petroleum fuels and environmental issues. So it seems that there is no turning back at lower prices. Such scenario's make one to think about electric powered vehicles. To start with such invention an electric bicycle will be the basic to understand the behaviour of electric propulsion. For short travelling the distance to reach at the work will be increased because of crazy traffic. Using car is also suicidal. Also there are not enough parking spaces and the one's available are quite expensive, with the e-bike it can be avoided, the never ending parking searching.

#### A. Introduction

There are three main components of electric vehicle battery, electric motor and power converter. In this, the method uses the PMSBLDC motor for propulsion and PWM control for controlling the speed for different speed ratio. The main disadvantage of an electric bike is its weight that can be modified and it can be designed as light weight electric vehicle through this method.

#### B. Modelling of Electric Bike

The first step in vehicle performance modelling is to produce an equation for the tractive effort. This is the force propelling the vehicle forward, transmitted to the ground. There are different types of forces occurred on bike like:

- Rolling resistance force (F roll)
- Hill climbing force (slope) (F slope)
- Acceleration force (F acceleration)
- Aerodynamic drag (Fad) or Wind force (F Wind)

#### C. Rolling Resistance Force (F roll)

It is primarily due to friction of the vehicle tyre on road. It is dependent on vehicle speed. It is proportional to vehicle weight. The typical value of  $\mu$ -0.0015 to 0.015. It is given by

$$F_{rr} = \mu * M * g * \cos(\text{angle})$$

Where  $\mu$ =coefficient of rolling resistance

M=Total mass of the vehicle

g=Acceleration due to gravity=9.81 m/s<sup>2</sup>

#### D. Hill Climbing Force (F slope)

The force needed to drive the vehicle up-slope is the most important to find. It is also known as weight. It is given by

$$F_{\text{slope}} = M * g * \sin(\text{angle})$$

#### E. Acceleration Force

If the velocity of the vehicle is change then clearly a force will need to apply in addition to the force. It can provide linear acceleration of the vehicle. It is given Newton's second law

$$F_{\text{acceleration}} = m * a$$

Where a=acceleration in m/s<sup>2</sup>

#### F. Aerodynamic Drag

Force is due to the friction of the vehicle body moving through the air. It is the function of frontal area, shape and other factor. It is given by

$$F_{ad} = (b * C_d * A * V^2) / 2$$

### IV. LITERATURE SURVEY

#### A. Design, Fabrication and Performance Analysis of Solar Power Bicycle

In this paper, authors carried the selections of different components of E-bike. Determination of Battery: Two Li-ion Battery storing with 12 V and 12 amp-hour rating are kept in use. The variety of battery relies upon its voltage, ampere and wattage rating and so forth. The whole energy of totally charged battery in two hours is 288 Watt-hours. Choice of Motor: A Brushless DC Motor (BLDC) for 300 Watts control with electronic compensation framework is painstakingly picked. Brushless DC Motors (BLDC) have many favored contrasted with mechanically moved DC motors in light of the fact that BLDC engines have permanent(long enduring) magnet, electronically drove, No twisting on rotors, frictionless operation, not so much commotion but rather more undeviating(uniform) torque.

**B. C.C.CHAN (2002)**

Talked about a reality where condition assurance and vitality preservation are developing concerns, the advancement of electric vehicles (EV) and half and half electric vehicles (HEV) has taken on a quickened pace. The fantasy of having industrially practical EVs and HEVs is turning into a reality. EVs and HEVs are step by step accessible in the market. This paper will give a diagram of the present status of electric and half breed vehicles worldwide and their cutting edge, with accentuation on the building logic and key innovations. The significance of the combination of innovations of vehicle, electric engine drive, hardware, vitality stockpiling, and controls and furthermore the significance of the reconciliation of society quality from government, industry, explore establishments, electric power utilities, and transportation experts are tended to. The test of EV commercialization is examined.

**V. RESULT ANALYSIS**

**A. CALCULATIONS**

Power Calculation:

One joule = 1Watt sec

Where power, P =  $\frac{\Delta E}{\Delta t}$

1 unit = 1 KW

1 Kwh = 1000Wh  
 =1000\*3600 sec  
 = 3600KW sec  
 =3600K joules

**B. Calculation for Charging of Battery**

S.N	CHARGING TIME OF BATTERY	POWER CONSUME D IN UNIT	BATTERY VOLTAGE LEVEL IN V
1	Initial condition	0	48
2	After 30 min	0.05	49
3	After 65 min	0.1	50
4	After 80 min	0.2	50.6
5	After 145 min	0.3	51.8
6	After 215 min	0.5	52.6
7	After 290 min	0.6	53.5



**Figure 5.1 Side View of Electric Bike**

**Advantages**

- Easy to commute with low fatigue.
- Less maintenance cost.
- Normal Drag/Pedal is possible when power is not in use.
- Deployable batteries – can be taken inside house.
- Cost of the unit is very low.
- Easy to carry since it is portable.
- Less energy consumed.
- High efficiency can be obtained if inverter is used.
- If using solar panel, free utilization of energy can be done.

**Disadvantages**

- High intensity of wind load.
- High centre of gravity.
- Cannot tolerate drastic changes in environment.

**VI. 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 electric 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 solar panel it can lessen up more. Since it has fewer

components it can be easily dismantled to small components, thus requiring less maintenance.

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