

Electric Bike using Lithium ION Battery

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Abstract: One of the greatest and most urgent needs of this world is to develop technology in the transport industry that can help reduce the consumption of fossil fuel exponentially. Our world faces the danger of over exploitation of fossil fuels which in turn is contributing to pollution and global warming. Thus, working on a solution for electric bikes that increase performance, sustenance and also optimize the cost is the need of the hour. Therefore, research on the global research trends of this topic was conducted [1]. Its evolution over time shows that since 2008 the growth of publications is much higher than in the previous period. The countries such as China, India and USA have been included in researches, and it can be inferred that there are two major trend countries with high environmental awareness, which also have a large population and that the electric bicycle is a suitable and sustainable form of transport. Lithium ion battery is fast being recognized as a sustainable battery option because of its superior performance and life cycle. Therefore, lithium ion battery based electric bikes can be major breakthrough in the transport industry [2].

Keywords: Lithium ion, electric bike, performance.

1. Introduction:

An electrically assisted pedal bicycle is known as an e-bicycle. [3] The first patent for electric bikes was given by Ogden Bolton Jr., which included a 6-pole brush, dc collector and a hub motor mounted on the rear wheel. Few years later, Hosea W. Libbey invented electric bike which was propelled by double electric motor. This motor was so designed that it was attached with the crankset axle. Later in 1990's torque sensors and power controls were developed including some modified versions of bike based on NiMH, NiCd and /or Li-ion batteries which offered lighter, density capacities batteries.[4]

E-bikes typically incorporate a battery, which can be charged at an ordinary domestic power socket, linked to an electric motor in the bicycle transmission system. The

rider has the power to controls the output power from motor i.e speed using a handlebar mounted computer display panel and controller. In our country the extent of the use of electric bikes is none to negligible. To tackle this problem, we need to address to aspects 1. Environmental 2. Cost. To enhance the performance of an e-bike a lithium ion based battery is used. The other parts of an electric bike include a brushless DC motor, throttle and controller. Cost optimization can be done through using lighter frames and motor and dynamo of appropriate rating. The purpose of this paper is to review the design of electric bicycle with simultaneous solar charging.

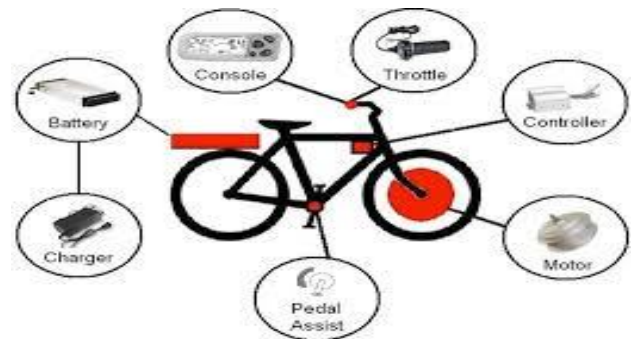


Fig (A) Block Diagram of E-bicycle components

In fig 1.1, the components are

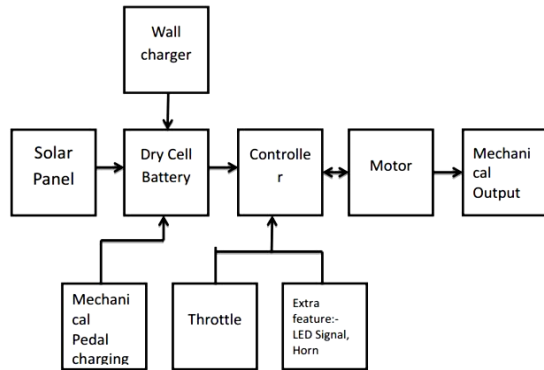
1. BLDC Motor
2. Li-Ion battery
3. Solar panel
4. Controller
5. Throttle

1.1 Objective: To review the design and application of Lithium ion battery based electric bikes and to optimize the cost by using multiple charging methods, the following objectives have been introduced:

1. To draw performance comparison between lead acid battery and lithium ion battery.

- To integrate solar panel into the model to provide simultaneous charging.

1.2 Block diagram and Specifications



- BLDC Motor:** The motor has 250W capacity with 2700 rpm.
Rated current: 14A
Rated voltage: 24V DC
- Battery:** The battery is a condenser which stores electric energy.
Rating : 12 V 9Ah

2. Design aspects:

1. **Lithium ion battery:** ZLi-ion is a low-maintenance battery, an advantage that most other chemistries cannot claim. The battery has no memory and does not need exercising (deliberate full discharge) to keep it in good shape. Self-discharge is less than half that of nickel-based systems and this helps the fuel gauge applications. Lithium-ion uses a cathode (positive electrode), an anode (negative electrode) and electrolyte as conductor. (The anode of a discharging battery is negative and the cathode positive (see BU-104b: Battery Building Blocks). The cathode is metal oxide and the anode consists of porous carbon[5]. During discharge, the ions flow from the anode to the cathode through the electrolyte and separator; charge reverses the direction and the ions flow from the cathode to the anode

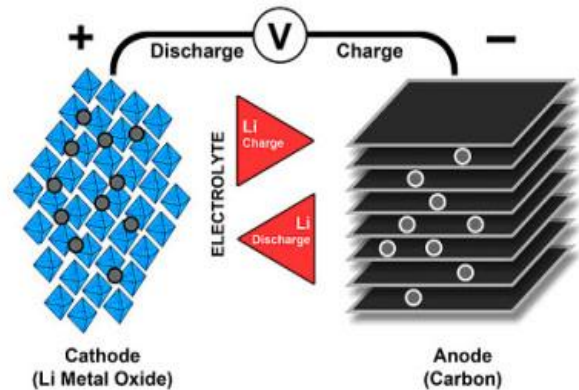


Fig (B) Charging and Discharging process of Lithium ion battery

A mathematical vehicle model will be developed and MATLAB simulation will be carried out for evaluation of power and energy requirements for a plug-in hybrid electric two wheelers for different driving cycles.

- A simple control strategy has to be developed for Indian city driving conditions with less fuel consumption for reducing emissions.
- A conventional two-wheeler will be converted into a plug-in hybrid electric two-wheeler by retrofitting a hub motor in the front wheel.
- Experiments will be carried out on engine and electric hub motor to estimate the power and torque requirements for various operating conditions. [2]

2.1 Advantages

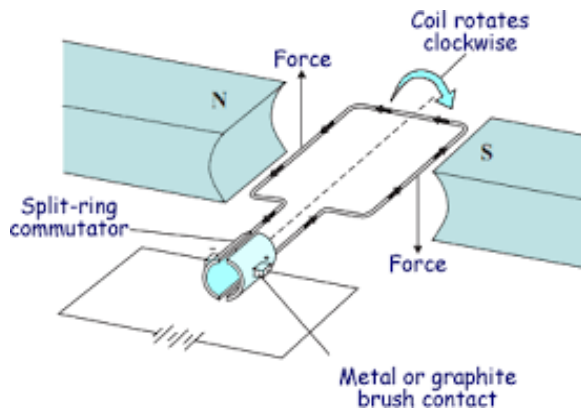
- High specific energy and high load capabilities with Power Cells
- Long cycle and extend shelf-life; maintenance-free
- High capacity, low internal resistance, good columbic efficiency.
- Simple charge algorithm and reasonably short charge times.
- Low self-discharge (less than half that of NiCd and NiMH).

3. Limitations

- Requires protection circuit to prevent thermal runaway if stressed.
- Degrades at high temperature and when stored at high voltage.

3. No rapid charge possible at freezing temperatures (<0°C, <32°F).

4. BLDC Motor: A BLDC motor is a powerful brushless DC motor that provides high performance



energy saving and speed control. The function of this motor is to convert the electrical energy that it receives into mechanical energy which results in motion of the bike. The most commonly used ratings for BLDC motor are 12V or 24V [6].

Electrical charging:

Time required to fully charging the battery is calculated.

Power Supplied to Battery during AC Charging: AC Adapter Specification: 12V, 3 A

$$P = V.I$$

$$P = 12 \times 3 \text{ P} = 36 \text{ W}$$

Therefore, the time required to charge the battery completely is: $t = 300 \div 36 \text{ t} = 8.5 \text{ hours}$ [6].

A controller is provided to help with speed control. All electric motors generate a voltage potential due to the movement of the windings through the associated magnetic field. This potential is known as an electromotive force (EMF) and, according to Lenz’s law, it gives rise to a current in the windings with a magnetic field that opposes the original change in magnetic flux. In simpler terms, this means the EMF tends to resist the rotation of the motor and is therefore referred to as “back” EMF. For a given motor of fixed magnetic flux and number of windings, the EMF is proportional to the angular velocity of the rotor.

But the back EMF, while adding some “drag” to the motor, can be used for an advantage. By monitoring the back EMF,

a microcontroller can determine the relative positions of stator and rotor. This simplifies motor construction, reducing its cost as well as eliminating the additional wiring and connections to the motor that would otherwise be needed to support the sensors.

4.1. Solar Panel: A solar panel of rating 12V 50W will be suitable to keep the speed and performance in check while also keeping the cost in check. The solar panel is basically a photovoltaic converter that converts the photons received from the sun to electrical energy which in turn charges the battery.

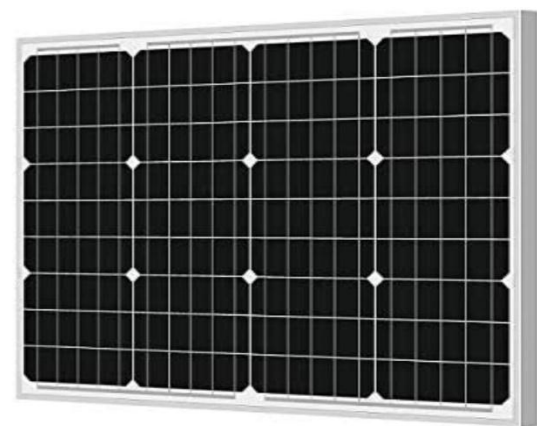


Fig (C) Mono Crystalline Solar Panel

4.2. Specification of Solar Panel

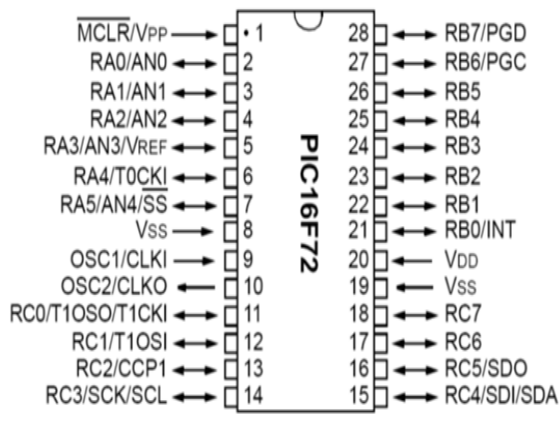
We have used loom solar 50watt mono panel are made of A grade mono perk cell and ultra cleared tempered glasses that does not break easily and gives 22% higher efficiency even in low light and cloudy weather. The main additional feature includes 4 bus-bars, 36 cells. IP67 rated junction box is given with MC4 compatible cable connector for higher module efficiency [8].

Maximum Power (Pmax)	50Wp
Maximum Power Voltage (VMP)	19.95V
Maximum Power Current (Imp)	2.51A
Short Circuit (Isc)	2.63V
Open circuit Volatge (Voc)	22.26V
Maximum System Voltage	600V

Table 4.2 (D)

5. PIC Controller: The responsibility of the controller is to provide control over different functions of the electric bicycle such as battery charging and discharging, motor speed control, pedal assist, over current protection,

voltage protection, control supply, etc. Here, we will use PIC16F72 to fulfill these functions. [7] In this PIC16F72 controller has 28 pins, 22 I/O pins that are user configurable on a pin-to-pin basis. There are 35 number of instructions in this PIC controller. The operating frequency is 20 MHz Also in this controller there are three I/O port are use such as PORT A, PORT B and PORT C and three Timers are use Timer0, Timer1 and Timer2.



The controller is installed with voltage and current transformers, IR sensor and temperature sensors to ensure detection of abnormal conditions in motor. With the help of current transformer which senses the current and if it exceeds rated value then PIC sends signal to relay to break the circuit and switch off the motor.

6. Conclusion: The solar hybrid bicycle is a very good application of renewable energy which will reduce pollution and can be useful device for villagers, where the provision of electricity is not adequate. Though the efficiency of solar cells is very low and it is also a costly device it has capability to sustain longer. It serves the purpose of not adding to any more pollution and to maintain a healthy population. A lot of research is going on for increasing the efficiency of solar cell with reduction in use of material thus making it a cheaper and cleaner form of energy.

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BIOGRAPHIES



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