Effective Utilization of Regenerative Braking in Electric Bike

[1]Ajil Tom [2]Issac Amal Justin. P [3] Varatharaj M [4] Citharthan D
[1,2,3]UG Scholar [4]Assistant professor
[1,2,3,4]Department of Electrical and Electronics Engineering
[1,2,3,4]Christ the King Engineering College, Coimbatore, Tamilnadu

Abstract

Conventional vechicles running on fossil fuel causes more global pollution and it creates an adverse effects on the environment. To bring out solution for this problem electric vechicle is introduced. To make it more effective regenerative braking system is implemented in this project. To reduce energy consumption regeneration is used, when brake is applied by the user regeneration occurs, the energy produced by the regeneration is stored in the battery. Among various categories of electric motors, normally permanent magnet synchronous motor, brushless dc motor, induction motor and switch reluctance motor are widely outed for the electric vechicle. Here we have used dc motor for regenerative braking.

Keyword- Electric Bike, Hybrid Braking System (HBS), Anti-Lock Braking System (ABS)

I. INTRODUCTION

Today due to global warming and rise of pollution index world is finding alternatives and solutions to reduce its harmful effect, where the electric vehicles offer a great opportunity of an emission-less vehicle over internal combustion engine vehicle. This electric vechicles are more efficient in energetic terms. Since the biggest weakness of electric vechicle, the autonomy, has been broken seems that the future of personal mobility must go through electric vechicles and renewable energy. Major automotive companies are involved in the development of new electric powertrains, and the investment in electrical vechicles had never been so high, also from many governments who supports purchasing of such vechicles with subsides of reduction of tax. Due to current limitation of electric power, electric vechicles must be lightweight since the weight of powertrain itself is already high to achieve the required autonomy. Motorcycles used in cities for the realization of short journeys do not need a high autonomy, that's why electric motorcycles or scooters in the scope of urban motoring are constantly in development.

Conventionally, Internal Combustion Engine (ICE) Vehicles were solely using the mechanical brake in which kinetic energy is dissipated in heat due to friction. Sometimes 50 % of an average of all energy used for traction is wasted in heat using mechanical brakes. 30.77% and 17.44% losses occur in the conventional vehicle during stopping and deceleration respectively. In most of the mechanical braking system vehicle decelerates due to friction imparted on wheels. Addition to its Anti-lock Braking System (ABS) driven by hydraulic actuators are used in the vehicle whose energy efficiency is low. In electric vehicle braking operation is carried out with a conjunction of regenerative and mechanical braking system, termed as Hybrid Braking System.

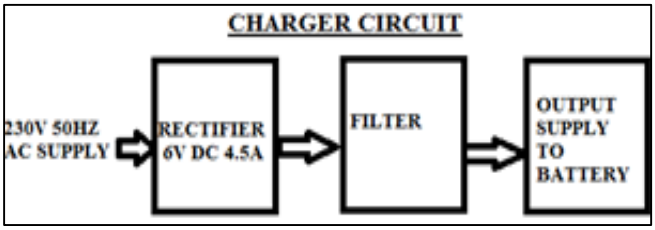
In Hybrid Braking System (HBS), distribution of braking force between regenerative and mechanical braking is significantly important. Recent research in HBS focuses on advanced braking control methodology for distribution of braking forces considering various limits about safety and comfort. The challenge in HBS is its complexity increases with Electronic braking and anti-lock braking system (ABS) control. Placement of motors is also an important part of regenerative braking and controller design depends on it. On the basis of placement of motors, the design of drive train and torque requirements of EVs, various control methods are, the front wheel drive control, Independently Driven front and rear wheel control, and in wheel control. Although regenerative braking is possible, still mechanical braking is required in any Electric vechile. It is mainly because of two reasons, first for fast braking, when regenerative braking gets fail or in an emergency when there are chances of collision or regenerative brake is not sufficient of two reasons, first for fast braking, when regenerative braking gets fail or in an emergency to stop the vechicle, second if a battery is fully charged that time to prevent battery from damage mechanical brakes can be used.

II. HARDWARE COMPONENTS

A. Power Supply

Since all electronic circuits work only with low D.C. voltage we need a power supply unit to provide the appropriate voltage supply. This unit consists of a battery and a charger for 6v 4.5amps battery.

B. Block Diagram for Charge Circuit



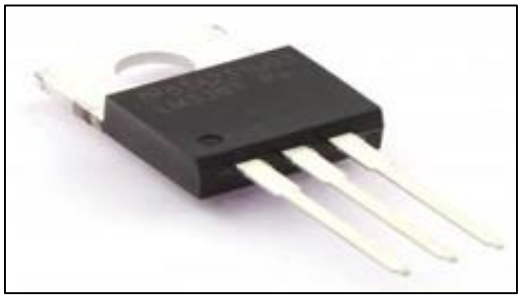
C. RECTIFIER

A rectifier is a device such as a semiconductor capable of converting sinusoidal input waveform units into a unidirectional waveform, with a non-zero average component.

D. FILTERS

Capacitors are used as filters in the power supply unit. Shunting the load with the capacitor, effects filtering. The action of the system depends upon the fact the capacitor stores energy during the conduction period and delivers this energy to the load during the inverse or non-conducting period. In this way, time during which the current passes through the load is prolonged and ripple is considerably reduced.

E. LM 138, LM 338



The LM138 series of adjustable 3-terminal positive voltage regulators is capable of supplying in excess of 5A over a 1.2V to 32V output range. They are exceptionally easy to use and require only 2 resistors to set the output voltage. Careful circuit design has resulted in outstanding load and line regulation comparable to many commercial power supplies. The LM138 family is supplied in a standard 3-lead transistor package.

A unique feature of the LM138 family is time-dependent current limiting. The current limit circuitry allows peak currents of up to 12A to be drawn from the regulator for short periods of time. This allows the LM138 to be used with heavy transient loads and speeds start-up under full-load conditions. Under sustained loading conditions, the current limit decreases to a safe value protecting the regulator. Also included on the chip are thermal overload protection and safe area protection for the power transistor. Overload protection remains functional even if the adjustment pin is accidentally disconnected. Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An output capacitor can be added to improve transient response, while bypassing the adjustment pin will increase the regulator's ripple rejection.

1) Features

- Guaranteed 7A peak output current
- Guaranteed 5A output current
- Adjustable output down to 1.2V
- Guaranteed thermal regulation
- Current limit constant with temperature
- Pa Product Enhancement tested
- Output is short-circuit protected

2) Applications

- Adjustable power supplies
- Constant current regulators
- Battery chargers

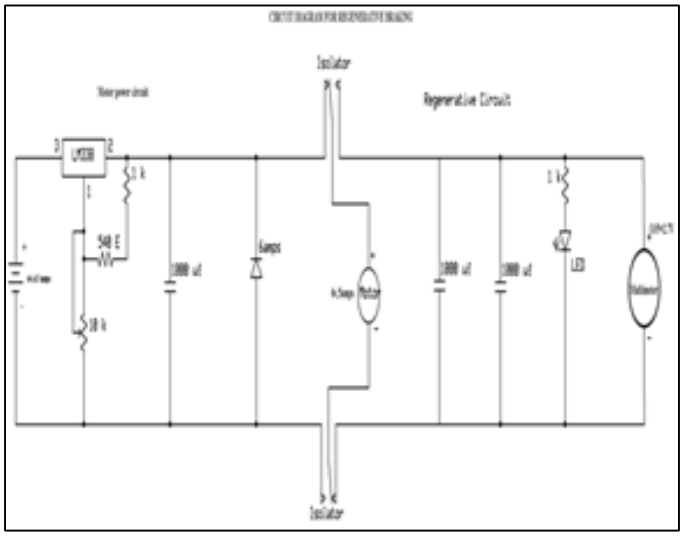
F. Switch

Electrical switches. Top, left to right: circuit breaker, mercury, wafer switch, DIP switch, surface mount switch, reed switch. Bottom, left to right: wall switch (U.S. style), miniature toggle switch, in-line switch, push-button switch, rocker switch, micro switch.

In electronics, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts. Each set of contacts can be in one of two states: either 'closed' meaning the contacts are touching and electricity can flow between them, or 'open', meaning the contacts are separated and nonconducting.

A switch may be directly manipulated by a human as a control signal to a system, such as a computer keyboard button, or to control power flow in a circuit, such as a light switch. Automatically-operated switches can be used to control the motions of machines, for example, to indicate that a garage door has reached its full open position or that a machine tool is in a position to accept another work piece. Switches may be operated by process variables such as pressure, temperature, flow, current, voltage, and force, acting as sensors in a process and used to automatically control a system. A switch that is operated by another electrical circuit is called a relay. Large switches may be remotely operated by a motor drive mechanism. Some switches are used to isolate electric power from a system, providing a visible point of isolation that can be pad-locked if necessary to prevent accidental operation of a machine during maintenance, or to prevent electric shock.

G. Circuit Diagram



III. CONVERSION OF KINETIC ENERGY TO MECHANICAL ENERGY USING FLYWHEEL ENERGY STORAGE

A flywheel is a type of energy storage system which is used to store mechanical energy and then release the stored energy when needed for acceleration. Flywheel is a heavy, high-speed rotating disc that builds up kinetic energy (the force that causes movement) as it spins. The amount of energy stored depends upon how heavier it is and how fast it rotates. Heavier weight and faster rotation results in higher energy storage. We can relate it to a discus thrower in the Olympics. He winds-up, building an increasing store of force and energy as he spins, and then releases the disc and sends it flying through the air. The method of

transmission of energy directly to the vehicle is more efficient rather than first storing it in the battery, as it does not consists of the conversion of energies. As, during the recharging of battery, mechanical energy is converted into electrical energy and during discharging electrical energy is converted into mechanical energy. So, due to these conversions transmission loses occur and the efficiency reduces. As, in the other case, there are no transmission loses since mechanical energy stored in the flywheel is directly transferred to the vehicle in its original form.

IV. CONVERSION OF KINETIC ENERGY TO ELECTRICAL ENERGY USING ELECTRIC MOTOR

The most common form of regenerative brake involves using an electric motor as an electric generator. The working of the regenerative braking system depends upon the working principle of an electric motor, which is the important component of the system. Electric motor gets activated when some electric current is passed through it. But, when some external force is applied to activate the motor (during the braking), then it behaves as a generator and generates electricity. This means that whenever motor runs in one direction, the electric energy gets converted into mechanical energy, which is then used to accelerate the vehicle and whenever the motor runs in opposite direction, it performs functions of a generator, which then converts mechanical energy into electrical energy, which makes it possible to utilize the rotational force of the driving axle to turn the electric motors, which results in regenerating electric energy for storage in the battery and simultaneously reducing the speed of the car with the regenerative resistance of the electric motors. This electricity is then used for recharging the battery.

V. REGENERATIVE BRAKING EFFICIENCY

The energy efficiency of a conventional car is only about 20 percent, with the remaining 80 percent of its energy being converted to heat through friction. The miraculous thing about regenerative braking is that it may be able to capture as much as half of that wasted energy and put it back to work. This could reduce fuel consumption by 10 to 25 percent. Hydraulic regenerative braking systems could provide even more impressive gains, potentially reducing fuel use by 25 to 45 percent. In a century that may see the end of the vast fossil fuel reserves that have provided us with energy for automotive and other technologies for many years, and in which fears about carbon emissions are coming to a peak, this added efficiency is becoming increasingly important. The added efficiency of regenerative braking also means less pain at the pump, since hybrids with electric motors and regenerative brakes can travel considerably farther on a gallon of gas, some achieving more than 50 miles per gallon at this point. And that's something that most drivers can really appreciate.

VI. APPLICATIONS OF REGENERATIVE BRAKING SYSTEMS

- For recovering Kinetic energy of vehicle lost during braking process.
- One theoretical application of regenerative braking would be in a manufacturing plant that moves material from one workstation to another on a conveyer system that stops at each point.
- Regenerative braking is used in some elevator and crane hoist motors.
- Regenerative Braking Systems are also used in electric railway vehicle (London Underground & Virgin Trains).

VII. ADVANTAGES OF REGENERATIVE BRAKING SYSTEMS

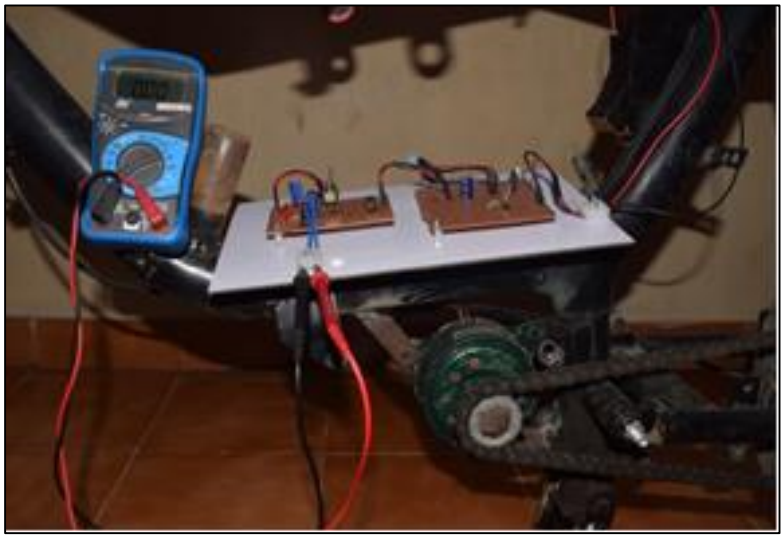
- Improved Performance
- Improved Fuel Economy- Dependent on duty cycles, power train design, control strategy, and the efficiency of individual components.
- Reduction in Engine wears.
- Reduction in Brake Wear- Reducing cost of replacement brake linings, cost of labor to install them, and vehicle down time,
- Emissions reduction- engine emissions reduced by engine decoupling, reducing total engine revolutions and total time of engine operation.
- Operating range is comparable with conventional vehicles- a problem not yet overcome by electric vehicles.

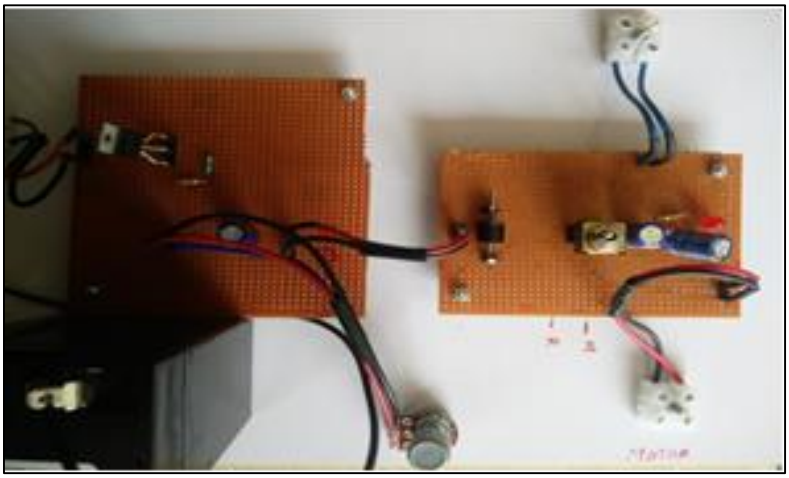
VIII. LIMITATIONS OF REGENERATIVE BRAKING SYSTEMS

- The main limitation of regenerative brakes when compared with dynamic brakes is the need to closely match the electricity generated with the supply.
- With DC supplies this requires the voltage to be closely controlled and it is only with the development of power electronics that it has been possible with AC supplies where the supply frequency must also be matched (this mainly applies to locomotives where an AC supply is rectified for DC motors).
- Regenerative braking is necessarily limited when the batteries are fully charged. Because the additional charge from regenerative braking would cause the voltage of a full battery to rise above a safe level, our motor controller will limit regenerative braking torque in this case.

- Increases the total weight of vehicle by around 25- 30 Kilograms.

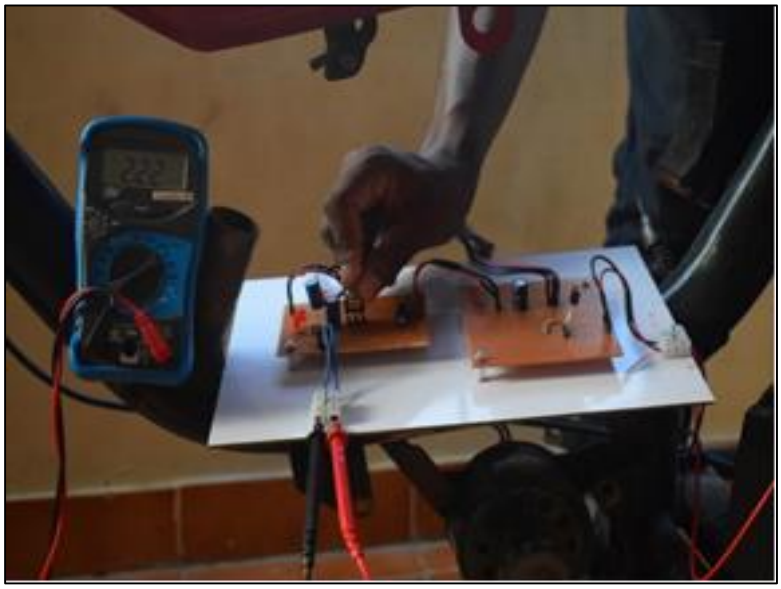
A. Hardware





B. Result

The output reading maximum is been given by the photograph



The maximum output voltage 2.22 volt, and the reading is been measured by the multimeter

C. Conclusion

The regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. Also it can be operated at high temperature range and are efficient as compared to conventional braking system. The results from some of the test conducted show that around 30% of the energy delivered can be recovered by the system. Regenerative braking system has a wide scope for further development and the energy savings. The use of more efficient systems could lead to huge savings in the economy of any country.

D. Future Scope

Regenerative braking systems require further research to develop a better system that captures more energy and stops faster. As the time passes, designers and engineers will perfect regenerative braking systems, so these systems will become more and more common. All vehicles in motion can benefit from these systems by recapturing energy that would have been lost during braking process.

Future technologies in regenerative brakes will include new types of motors which will be more efficient as generators, new drive train designs which will be built with regenerative braking in mind, and electric systems which will be less prone to energy losses. Of course, problems are expected as any new technology is perfected, but few future technologies have more potential for improving vehicle efficiency.

REFERENCES

[1] S. M. Reza Tousi, S. Omid Golpayegani, Ehsan Sharifian "Anti-Lock Regenerative Braking Torque Control Strategy for Electric Vehicle", Industrial Technology (ICIT), 2016 IEEE International Conference on, 1417 March 2016

[2] Yufeng Lian, Yun Zhao, Leilei Hu, and Yantao Tian "Longitudinal Collision Avoidance Control of Electric Vehicles Based on a New Safety Distance Model and Constrained-Regenerative-Braking-StrengthContinuity Braking Force Distribution Strategy", IEEE Transactions on Vehicular Technology, Vol. 65, No. 6, June 2016

[3] Farshid Naseri, Ebrahim Farjah,Teymoor Ghanbari "An Efficient Regenerative Braking System Based on Battery/Supercapacitor for Electric, Hybrid and Plug-In Hybrid Electric Vehicles with BLDC Motor", IEEE Transactions on Vehicular Technology.