Power Generation in Smart City by Used of Kinetic Energy of Vehicles from Speed Breaker

Sharad Chandra Rajpoot[1] Prashant Singh Rajpoot[2] Sudhabala Gupta[3] Shweta Thakur[4]
[1,2]Assistant Professor [3]M.Tech Scholar [4]B.Tech Scholar
[1,2]Department of Electrical Engineering
[1]G.E.C. Jagdalpur, Bastar, Chhattisgarh, India [2,4]L.C.I.T., Bilaspur, Chhattisgarh, India [3]SRIT, Jabalpur, Madhayapradesh, India

Abstract— When a conventional vehicle applies its brakes, kinetic energy is converted to heat as friction between the brake pads and the wheels. This heat is carries away in the airstream and the energy is effectively wasted. The total amount of energy lost in this way depends on how often, how hard and for how long the brakes are applied. Regenerative Braking System is the way of slowing vehicle by using the motors as brakes. Instead of the surplus energy of the vehicle being wasted as unwanted heat, the motors act as generators and return some of it to the overhead wires as electricity. The vehicle is primarily powered from the electrical energy generated from the generator, which burns gasoline. This energy is stored in a large battery, and used by an electric motor that provides motive force to the wheels. The regenerative braking taking place on the vehicle is a way to obtain more efficiency; instead of converting kinetic energy to thermal energy through frictional braking, the vehicle can convert a good fraction of its kinetic energy back into charge in the battery, using the same principle as an alternator.

Key words: Non-Conventional Energy Sources, Speed Breaker Power, Generator, Roller Mechanism

I. INTRODUCTION

Regenerative Braking System is the way of slowing vehicle by using the motors as brakes. Instead of the surplus energy of the vehicle being wasted as unwanted heat, the motors act as generators and return some of it to the overhead wires as electricity.

A brake is a machine element and its principle object is to absorb energy during deceleration. In vehicle brakes are used to absorb kinetic energy whereas in hoists or elevators brakes are also used to absorb potential energy. By connecting the moving member to stationary frame, normally brake converts kinetic energy to heat energy. This causes wastage of energy and also wearing of frictional lining material.

The vehicle is primarily powered from the electrical energy generated from the generator, which burns gasoline. This energy is stored in a large battery, and used by an electric motor that provides motive force to the wheels. The regenerative braking taking place on the vehicle is a way to obtain more efficiency; instead of converting kinetic energy to thermal energy through frictional braking, the vehicle can convert a good fraction of its kinetic energy back into charge in the battery, using the same principle as an alternator.

II. REGENERATIVE BRAKING SYSTEM

A. Definition

Braking method in which the mechanical energy from the load is converted into electric energy and regenerated back into the line is known as Regenerative Braking. The Motor operates as generator.

B. Regenerative Braking System

Regenerative braking takes place whenever the speed of the motor exceeds the synchronous speed. This baking method is called regenerative braking because here the motor works as generator and supply itself is given power from the load, i.e. motors. The main criteria for regenerative braking is that the rotor has to rotate at a speed higher than synchronous speed, only then the motor will act as a generator and the direction of current flow through the circuit and direction of the torque reverses and braking takes place. The only disadvantage of this type of braking is that the motor has to run at super synchronous speed which may damage the motor mechanically and electrically, but regenerative braking can be done at sub synchronous speed if the variable frequency source is available.

The vehicle is primarily powered from the electrical energy generated from the generator, which burns gasoline. This energy is stored in a large battery, and used by an electric motor that provides motive force to the wheels. The regenerative braking taking place on the vehicle is a way to obtain more efficiency; instead of converting kinetic energy to thermal energy through frictional braking, the vehicle can convert a good fraction of its kinetic energy back into charge in the battery, using the same principle as an alternator.

C. Regenerative Braking For Hybrid Vehicle

In most electric and hybrid electric vehicles on the road today, this is accomplished by operating the traction motor as a generator, providing braking torque to the wheels and recharging the traction batteries. The energy provided by regenerative braking can then be used for propulsion or to power vehicle accessories.

D. Necessity of the System

The regenerative braking system delivers a number of significant advantages over a car that only has friction brakes. In low-speed, stop-and-go traffic where little deceleration is required; the regenerative braking system can provide the majority of the total braking force. This vastly improves fuel economy with a vehicle, and further enhances the attractiveness of vehicles using regenerative braking for city driving. At higher speeds, too, regenerative braking has been shown to contribute to improved fuel economy – by as much as 20%.

III. REGENERATIVE BRAKING IN RAIL VEHICLES

Dynamic Braking has been frequently used in rail vehicles to reduce brake wear Diesel-Electric locomotives require onboard energy storage for regeneration. Some electric

rail/overhead line locomotives with regenerative braking can send power back through supply line. Power can be received by other trains connected to the line or sent back to the grid.

A. AC Locomotives

- Can feed power back into the grid without the need for large power inverters.
- The New Delhi Metro, after implementing regenerative capabilities, cut down its power consumption by 30%, a total savings of 112MWh between 2004-2007.
- Other AC traction lines in the UK and NZ have achieved improvements of 15-17%.

B. DC Locomotives

- Cannot easily feed power back to external networks but it can power other trains on the same line.
- Efficiency depends on the number of nearby locomotives that can receive power from regeneration.

C. Regenerative Braking In Road Vehicles

- Road vehicles require onboard energy storage as well as relatively quick braking compared to rail vehicles.
- Regenerative braking improves the efficiency in stop and go city traffic more than high speed travel.
- Efficiency gains vary greatly from vehicle to vehicle and under the driving conditions.
- Prius regenerative efficiency ≈ 30%.

D. Cars with Regenerative Braking

- Toyota Prius.
- Honda Insight.
- Ford Escape Hybrid.
- Tesla Roadster.
- Chevy Volt.

IV. Elements of the System

There are three basic element required which are necessary for the working of regenerative braking system, these are:

A. Energy Storage Unit (ESU)

The ESU performs two primary functions:-

- To recover & store braking energy.
- To absorb excess engine energy during light load operation

The selection criteria for an effective energy storage includes:

- High specific energy storage density.
- High energy transfer rate.
- Small space requirement

The energy recaptured by regenerative braking might be stored in one of three devices: an electrochemical battery, a flywheel, in a regenerative fuel cell.

1) Regenerative and Batteries

With this system, the electric motor of a car becomes a generator when the brake pedal is applied. The kinetic energy of the car is used to generate electricity that is then used to recharge the batteries. With this system, traditional friction brakes must also be used to ensure that the car slows down as much as necessary. Thus, not all of the kinetic energy of the car can be harnessed for the batteries because some of it is "lost" to waste heat. Some energy is also lost to resistance as the energy travels from the wheel and axle, through the drive train and electric motor, and into the battery. For example, the Toyota Prius can only recapture about 30% of the vehicles kinetic energy.

The Honda Insight is another vehicle in addition to the Prius that is on the market and currently uses regenerative braking. In the Insight there are two deceleration modes. When the throttle is engaged, but the brake pedal is not, the vehicle slows down gradually, and the battery receives a partial charge.

When the brake pedal is depressed, the battery receives a higher charge, which slows the vehicle down faster. The further the brake pedal is depressed, the more the conventional friction brakes are employed.

2) Regenerative and Flywheels

In this system, the translational energy of the vehicle is transferred into rotational energy in the flywheel, which stores the energy until it is needed to accelerate the vehicle. The benefit of using flywheel technology is that more of the forward inertial energy of the car can be captured than in batteries, because the flywheel can be engaged even during relatively short intervals of braking and acceleration. In the case of batteries, they are not able to accept charge at these rapid intervals, and thus more energy is lost to friction. Another advantage of flywheel technology is that the additional power supplied by the flywheel during acceleration substantially supplements the power output of the small engine that hybrid vehicles are equipped with.

3) Regenerative and Fuel Cells

The third system uses what is known as a unitized regenerative fuel cell, which is designed to both convert hydrogen and oxygen into energy and water, or be reversed to take the energy from the wheels, combine it with water, and produce hydrogen and oxygen. The system as a single unit is substantially lighter than a separate electrolyzer and generator, which makes this system (known as a URFC) especially beneficial when weight is a factor. When the URFC is paired up with lightweight hydrogen storage, it's energy density of about 450 watt-hours per kilogram is ten times that of lead-acid batteries and twice as much as any predictions for the energy density of forthcoming chemical batteries. This means that not only will this technology make lighter hybrids available, it will also give hybrids a driving range that is comparable to that of vehicles today that are equipped with conventional engines. Further benefits of the URFC is that it will be more cost effective than other vehicles because it will not need to be replaced, and it will provide the additional power needed by an electric engine when accelerating onto a highway.

B. CVT Transmission

The energy storage unit requires a transmission that can handle torque and speed demands in a steeples manner and smoothly control energy flow to and from the vehicle wheels. For the flywheel the continuously variable transmission and vehicle because flywheel rotational speed increases when vehicle speed decreases and vice versa. Flywheel can work well with either mechanical or hydrostatic continuously variable transmission.

C. Control System

An "ON-OFF" engine control system is used. That means that the engine is "ON" until the energy storage unit has been reached the desired charge capacity and then is decoupled and stopped until the energy storage unit charge fall below its minimum requirement.

V. COMPONENT DESCRIPTION

1) 12-0-12 TRANSFORMER (5 AMP)
2) DIODE (IN5402, BYV62E, IN 4007)
3) CAPACITOR (4700 MICRO FARADAY, 0.44Uf)
4) 7812 VOLTAGE REGULATOR
5) IRF2807 MOSFET
6) INDUCTOR 1000 UHENRY
7) 10V ZENER DIODE
8) RESISTOR (10K, 470 OHM, 2.2 K)
9) 10 MM LED

A. Transformer Configurations

A 120 volt transformer with two wires in and two wires out is very simple. You hook up the two wires on the primary side, the 120V side, to a wall outlet and your output voltage is on the two wires coming from the secondary side.

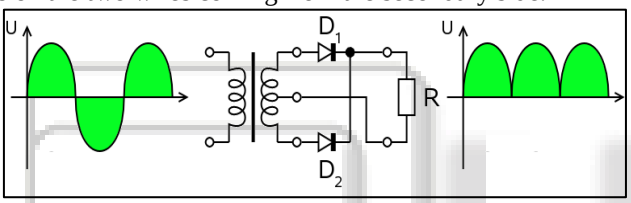

Fig. 1:

B. Diode Rectifier CKT

One of the important applications of a semiconductor diode is in rectification of AC signals to DC. Diodes are very commonly used for obtaining DC voltage supplies from the readily available AC voltage.

The voltage obtained across the load resistor of the full-wave bridge rectifier described above has a large amount of ripple. A capacitor filter may be added to smoothen the ripple in the output, as shown below.

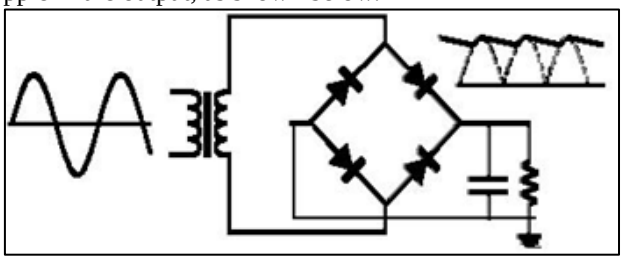

Fig. 2: Full wave Bridge Rectifier with Capacitor Filter

The rectifier circuits discussed above can be used to charge batteries and to convert AC voltages into constant DC voltages. Full-wave and bridge rectifier are more commonly used than half-wave rectifier.

C. Capacitor

Capacitors are electronic components that store, filter and regulate electrical energy and current flow and are one of the essential passive components used in circuit boards. Capacitors are primarily used for storing electrical charges, conducting alternating current (AC), and blocking or separating different voltages levels of direct current (DC) source.

Dielectric Material	Dielectric Constant
Vacuum	1
Air	1.0006
Polypropylene PP	2.2
Polyphenylene Sulfide PPS	3
Polyester PET	3.3
Polyester PEN	3.0
Impregnated Paper	2.0-6.0
Mica	6.8
Aluminum Oxide	8.5
Tantalum Oxide	27.7
Para electric Ceramics (Class 1)	5-90
Barium Titan ate (Class 2)	3000-8000

Fig. 1: Dielectric Constants of Commonly used Capacitor Materials

D. Inductor

Inductor is a passive component designed to resist changes in current. Inductors are often referred to as "AC resistors". The ability to resist changes in current and store energy in its magnetic field account for the bulk of the useful properties of inductors. Current passing through an inductor will produce a magnetic field. A changing magnetic field induces a voltage which opposes the field-producing current. This property of impeding changes of current is known as inductance.

1) Types

- Wire wound Inductor
- Multilayer Ferrite Inductor
- Multilayer Ceramic Inductor
- Film Inductor
- Laser Cut Inductor

E. Filter

A circuit or device whose purpose is to control electrical energy at a given frequency or over a range of frequencies. Groups of passive components are commonly used to construct many types of filters. These passive components include resistors, capacitors and inductors.

1) PI-Filter

A filter consisting of two capacitors connected in parallel with a series inductor. These filters are commonly found near dc-to-dc converters to filter ripple current and voltage.

F. MOSFET

Power MOSFETs (Metal Oxide Semiconductor Field Effect Transistor) are the most commonly used power devices due to their low gate drive power, fast switching speed and superior paralleling capability. Most power MOSFETs feature a vertical structure with Source and Drain on opposite sides of the wafer in order to support higher current and voltage. Figure 8 show the basic device structures of Trench and Planar MOSFETs respectively. Trench MOSFETs are mainly used for <200V voltage rating due to their higher channel density and thus lower on-resistance. Planar MOSFETs are good for higher voltage ratings since on-resistance is dominated by epi-layer resistance and high cell density is not beneficial. The basic MOSFET operation is the same for both structures.

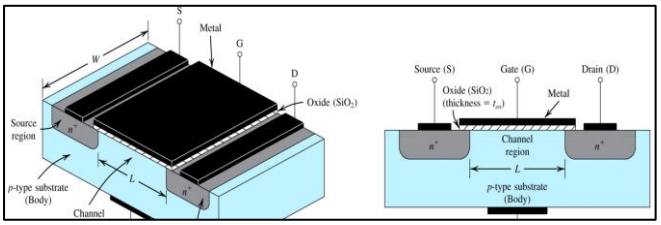

Fig. 3: MOSFET Structure

G. *Power Supply*

Every electronics circuit runs on a power-source of some kind. This design is based around 4 main parts. A transformer (optional in case of DC-input voltage), a bridge rectifier, a smoothing capacitor and the LM78XX chip which contains a 'linear voltage regulator'. The design is split up in a part that concerns itself with transforming AC into DC and a part that explains just how to regulate the DC part with the LM78xx chip.

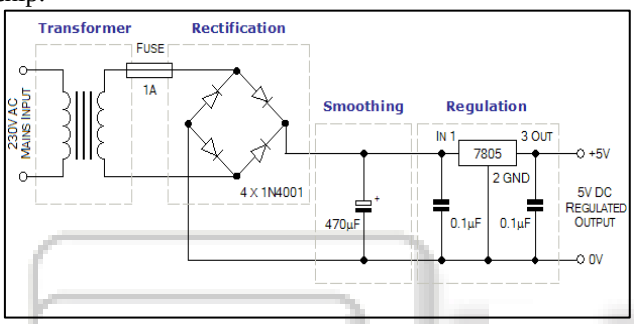

Fig. 4: Schematic Diagram of Power Supply Circuitry

H. *LED*

A Light emitting diode (LED) is essentially a p-n junction diode. When carriers are injected across a forward-biased junction, it emits incoherent light. Most of the commercial LEDs are realized using a highly doped n and a p Junction.

VI. OPERATION

Regenerative (or Dynamic Braking) occurs when the vehicle is in motion, such as coasting, traveling downhill or braking. And the accelerator pedal is not being depressed. During "Regent," the motor becomes a generator and sends energy back to the batteries.

It is explained as follows, because the wheels of a decelerating vehicle are still moving forward, they can be made to turn the electric motor, which then feeds energy to the batteries for storage. The system becomes, in effect, a generator, which provides braking force while it converts the vehicle's kinetic energy into a reusable form electrical energy.

When the accelerator pedal is released, the absence of pressure triggers a response from the Energy Storage Unit (ESU). Regenerative braking begins, and the batteries are re-charged by the motor, which is turned by the wheels. In this case, the friction brakes are not engaged. If more vigorous deceleration is required, and the brake pedal is depressed, this engages both sets of brakes. However, to maximize energy efficiency, it is advantageous to apply the regenerative brake as such as possible – it therefore tends to do more of its total work in the first part of the braking motion.

There are two deceleration modes:

A. *Foot off Throttle but not on Brake Pedal*

In this mode, the charge/assist gauge will show partial charge, and the vehicle will slow down gradually.

B. *Foot on Brake Pedal*

In this mode, a higher amount of regeneration will be allowed, and the vehicle will slow more rapidly. During light brake pedal application, only the IMA motor//generator is slowing the car. With heavier brake pedal application, the conventional friction brakes also come into play. When decelerating, regeneration will continue until engine speed falls to about 1000 rpm. At this point, the driver will typically shift into neutral.

VII. FINAL PROJECT PICTURE

Fig. 5: Model of Regenerative Braking System

VIII. ADVANTAGES

- Power generation with Very economically and using non-conventional energy sources which will help us to conserve the conventional energy sources to meet the future demand.
- Easy for maintenance and no fuel transportation problem.
- Pollution free power generation.
- Less floor area required and no obstruction to traffic.
- No need of manpower during power generation.

IX. CONCLUSION

"Electricity plays a very important role in our life". Due to population explosion, the current power generation has become insufficient to fulfill our requirements. In this project we discover technology to generate electricity from speed breakers in which the system used is reliable and this technique will help conserve our natural resources. In coming days, this will prove a great boon to the world, since it will save a lot of electricity of power plants that gets wasted in illuminating the street lights. As the conventional sources are depleting very fast, it's high time to think of alternative resources. We got to save the power gained from the conventional sources for efficient use. So this idea not only provides alternative but also adds to the economy of the country.

REFERENCES

[1] Mukherjee.D Chakrabarti.S, *Non-conventional power plants* (Public printing service, New Delhi, 2005).
[2] Ankita, Meenu Bala, *Power Generation From Speed Breakers*, International Journal Of Advance Research In Science and Engineering, 2(2), 2013.
[3] Miller R, *Power System Operation*, (McGraw- Hill, New York, 1970).

