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i-Eloop Regenerative Braking System

Dibya Narayan Behera, Subham Chattopadhyay, Sanjib Banerjee, Soumya Swaroop Swain

1 Asst Professor, 2, 3, 4 B.Tech Mechanical Students.
Subham9470@gmail.com
Department of Mechanical Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Rayagada Odisha, India

Abstract

In recent years, increased concerns over the impact of the conventional car (ICE –Internal Combustion Engine) on the environment have led to renewed interest and advancement in the Electric Vehicle (EV). The need to improve overall efficiency of the vehicle has led to the design of the regenerative braking system (RBS). The RBS will be used to convert the car’s mechanical energy and also the heat that would have been lost during braking into electrical energy.

Brake energy regeneration systems convert a vehicle's kinetic energy into electricity as the car decelerates. The electricity is then stored for later use. It can be used to power the headlights, climate control, audio system, or any other electrical equipment. This reduces the need for the engine to burn extra fuel in order to generate electricity, and thereby improves fuel economy.

Keywords: - *Brake energy regeneration, electricity, decelerates, fuel economy*.

1. Introduction

When a conventional vehicle applies its brakes, kinetic energy is converted to heat as friction between the brake pads and 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 refers to a process in which a portion of the kinetic energy of the vehicle is stored by a short term storage system. Energy normally dissipated in the brakes is directed by a power transmission system to the energy store during deceleration. That energy is held until required again by the vehicle, whereby it is converted back into kinetic energy and used to accelerate the vehicle.

i-ELOOP performs three functions; 'regeneration,' 'storage' and 'use.' In order to develop a system which efficiently recaptures kinetic energy, generates electricity, quickly stores that electricity, We have utilize variable voltage alternator and low-resistance, high-capacity electric double layer capacitor (EDLC). Conventional alternator charges at around 12 volts (V), however i-ELOOP's variable voltage alternator can vary its output voltage from 12 V to 25V in response to the voltage level of the capacitor and making it possible to continually supply electricity to the capacitor.

Unlike the battery that works on chemical reactions, capacitor stores energy in the form of electricity and can quickly charge and discharge large amount of electricity. The electrodes do not erode on prolonged usage as in case of the battery. Using capacitor in regenerative braking system not only increases the fuel efficiency but also increases the vehicle lead acid battery.

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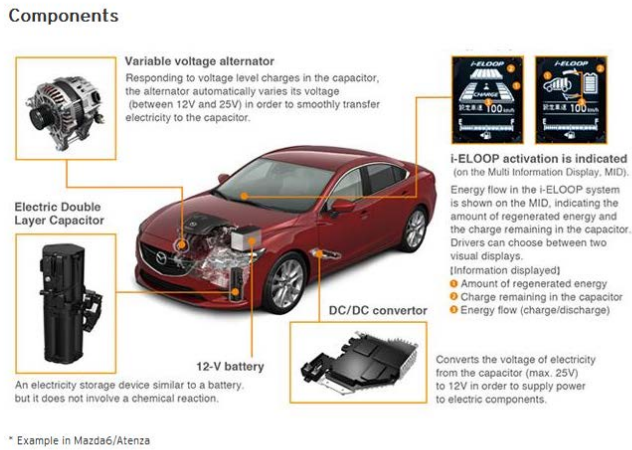


Recapture kinetic energy when car decelerates (accelerator released)

Energy that previously went to waste. When the accelerator is released, a high-performance alternator driven by the rotation of the tires generates electricity which is transferred to the capacitor.

Improved engine efficiency (when accelerating)

The alternator is switched off when the driver steps on the accelerator and the capacitor supplies electricity to the car's electronic components. The engine is relieved from the task of producing electricity resulting in improved fuel economy.

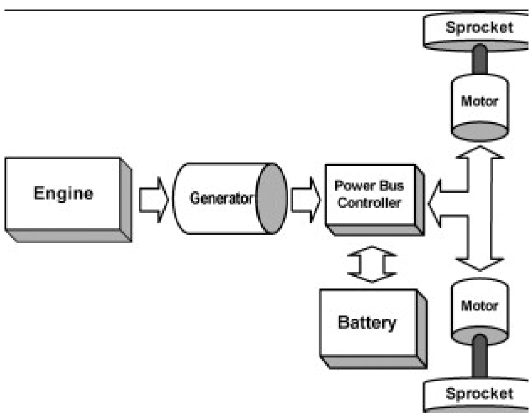
2. Literature Review

N.D.Vaughan, REDorey [1] said Regenerative Braking for an Electric Vehicle Using Ultra capacitors and a Buck-Boost Converter: An ultra-capacitor bank control system for an Electric Vehicle has been simulated. The purpose of this device is to allow higher accelerations and decelerations of the vehicle with minimal loss of energy, and minimal degradation of the main battery pack. The system uses an IGBT Buck- Boost converter, which is connected to the ultra-capacitor bank at the Boost side, and to the main battery at the Buck side. **M.R.Jones. (Staff.Uni) [2]** Fulfilling the 12 V DC battery requirements, we found a unit from Universal Battery with 18 Ah. If the battery is discharged to 50% at most, this battery leaves us with 9 Ah. Our load of lighting, music, and an iPod charger uses about 20 watts, but with an alternative appliance connected (e.g. phone), the total power consumed could be estimated at 25 watts. With a 12 VDC battery and a 25 W load, we have about 2 A of current, which gives us about 4.5 hours of use at full load – this is consistent with our design specifications. The exact battery we selected is UB12180 (12V 10Ah). An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. **M.L.Poulton. Computational [3**] Electrically driven vehicles can give a saving of energy if, with suitable control equipment, they can convert KE to electrical energy for storage and re-use. The drive motor of an electric vehicle can be made to operate as a genera supplying a resistive load and braking torque to the wheels. In regenerative braking, the electric vehicle motor operates as a generator to charge the battery. The process is less efficient at low power because of the substantial fixed mechanical losses, thus regeneration is not possible at low speeds and must be supplemented by mechanical brakes. **Hybrid NRHL [4]** A vehicle which contains two such sources of propulsion (an internal combustion engine (ICE) and an energy storage device) is known as a hybrid system [2, 3, 4]. Generally, a series hybrid drive, figure 1, has three main system components, ICE, generator and electric motor, which are arranged in series. The mechanical energy generated by the ICE is converted to electrical energy by the generator and this is again converted into mechanical energy in the electric motor.

3. Experimentation

A brake is a tool that enables in deceleration of a moving object; they use friction to convert kinetic energy into heat. Conventional braking systems use this mechanism. Once the brake pads rub against the wheels of the car, excessive heat energy is produced. The heat generated is lost into the air nearly accounting for about 30% of the car's generated power. The project here "Regenerative Braking System Project For Mechanical Students" introduces a different braking technology.

In this system, regenerative braking mechanism reuses the energy created by the braking process and uses this energy to charge the battery for further use. Generally the energy lost in the conventional use is transferred to the generator of the rotating wheel and is given to the battery. This saves a lot of energy.



The driving system of the vehicle is responsible for most of the braking process. As soon as the driver steps onto the brake pedal of the vehicle (either hybrid or electrical), the brakes put the vehicle's motor in the reverse mode enabling it to run backwards causing the wheels to slow down. While in the reverse mode, the motor operates as an electric generator feeding this electricity into the vehicle's batteries.

Most of the hybrid and electric vehicles in the market employ this technique to extend the life span of the battery pack. It is highly beneficial to use regenerative mechanism as it reduces pollution and also increases the engine life.

The amount of stored energy and maximum power extraction depends on vehicle performance specifications, the conversion efficiency and the efficiencies of the components in the drive train. Performance specifications should be similar to existing automobiles to obtain acceptance in the market place. Typical specifications are:

- Mass Vehicle (inc. Fuel) 1600 kg
- Passengers 400 kg
- Luggage 200 kg

- Total 2200 kg
- R a w 250 km at constant speed of 48 lanlh
- 200 km at constant speed of 88
- 10 km 10% slope constant speed of 48 km/h
- speed Maximum l20 rpm
- Acceleration From 0-96 km/h in 10 S
- Deceleration From 96-0 km/h in 7 S
- Rapid recharge Fully charged in less than 40 min
- Slow recharge Fully charged in 8 h
- Anx.power Air-conditioning heating 3 kW
- Windscreen wipers 0.1 kW
- Lights l kW
- Radio I hi-fi 0.2 kW
- Electric windows 0.2 kW
- Cooling pump and fan 1.5 kW
- Total 6 kW
- Efficiencies Motors 95%
- Gearboxes 99%
- Controllers (invaders) 97%
- Controlled rectifier 98%
- Flywheel generator 95%
- Batteries 92%

Minimum energy storage of 78 kWh is required to give the automobile a range of 200-250 inns. This is based on a total vehicle weight of 2200 kg and is significantly less if a lighter vehicle is used. The power requirements depend upon the maximum acceleration/deceleration rates of the vehicle and the allowable time to recharge the batteries or flywheel. A minimum power of 94 kW is required to meet the specified acceleration/deceleration rates.

Calculations

Total possible recoverable energy is the amount of energy needed to stop the vehicle.

Assumption: Ignore air resistance.

Mass of car = 2000Kg

Speed =100Km/Hrs

Efficiency=60%

Kinetic Energy= (1/2)*mass*speed^2

= 848.765Kj (energy can be recovered)

So the system being 60% efficient = .60*848.765

= 509.259Kj (actually recovered)

Gas saved

Gasoline recovered = mass* energy density of gasoline

(43,000Kj/Kg)

E=M*(e/m) efficiency of ice engine

So considering efficiency =30%

E= 509.259Kj

M=.027Kg

So we know that

1ltr gas=.75kg

Amount of gas saved =.036ltr.

4. Results and Analysis

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.

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

LIMITATIONS OF REGENERATIVE BRAKING SYSTEMS

- Regenerative braking is necessarily limited when the batteries are fully charged
- Increases the total weight of vehicle by around 25- 30 Kilograms

5. Conclusion

In this project Regenerative Braking system, the regenerative brake captures about half of the energy wasted and is utilized by the engine whereas in conventional brakes, 80% energy is wasted. Hence fuel consumption is reduced by 10 to 25 percent in regenerative braking. Not only this, speed of the vehicle is also greatly enhanced by this mechanism of braking.

What we've seen is that i-ELOOP is effective, and doesn't at all get in the way of the 3's responsive power train. We think that this capacitor-based system is a viable possibility for boosting fuel efficiency in the future. So did we get better mileage with i-ELOOP than without it? Probably, yes; but we have no way of measuring that. If there's room for improvement in the info screens for i-ELOOP, it would be to allow a display that actually shows how much energy the system has stored away—along with a projection of how much fuel it's saved versus a conventional.

Regenerative braking systems require further research to develop a better system that captures more energy and stops faster. All vehicles in motion can benefit from these systems by recapturing energy that would have been lost during braking process.

This i-Eloop regenerative braking will not only help in coping up with the shortage of fossil fuel but will also help in minimizing the energy loss. The regenerative braking will help to give a greater amount of output in small input.

6. Reference

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