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GENERATION OF ELECTRIC POWER IN HYBRID/ELECTRIC VEHICLES USING REGENERATIVE BRAKING SYSTEM

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ABSTRACT

The Regenerative Braking System of the hybrid/electrical vehicle is a key technology for improving the efficiency of the automobile by 20-40% depending on motor size. Regenerative braking contributes toward increasing the range of hybrid/electrical vehicles. Energy normally dissipated in the brakes is directed by a power transmission system to the energy store during deceleration. It helps to save fuel in hybrid vehicles and to reduce emissions of CO2 and pollutants, particularly in urban traffic situations involving frequent braking and acceleration. In addition, using the generator for braking also reduces brake wear and the build-up of brake dust.

KEYWORDS: Hybrid/Electric Vehicle, Regenerative Braking System, Friction, Motor and Generator

INTRODUCTION

For three decades now, the second commandment of every automotive engineer – right behind 'reduce cost' – has been 'reduce fuel consumption'. New technologies in automobile engineering are required to reduce automotive emissions and help to save our environment. Conventional braking systems use friction to counteract the forward momentum of the car.

Two versions of regenerative braking are currently available. The first type is serial regenerative braking that is based on a combination of a friction-based adjustable braking system with a regenerative braking system that transfers energy to the electric motors and batteries under an integrated control strategy. The second type is a parallel braking system in which the friction- based braking system and the regenerative braking system are operated in tandem, without integrated control which means that neither the friction braking force nor the regenerative braking force can be adjusted easily. In this paper we present the braking of the second type.

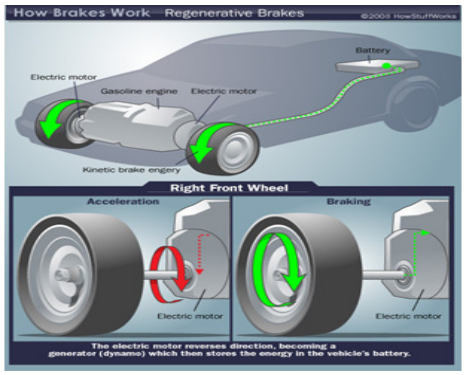

Figure 1: Functioning of Regenerative Braking System (RBS)

Figure 1 shows the functioning of regenerative braking system.Transferring torque back to the motor is the key to reclaim the energy from the brakes and motor.Through the technology of the motor and motor controller, the force at the wheels becomes torque on the electric motor shaft. The magnets on the shaft of the motor (called the rotor—the moving part of the motor) move past the electric coils on the stator (the stationary part of the motor), passing the magnetic fields of the magnets through the coils, producing electricity. This electricity becomes electrical energy, which is pumped back to the battery. This, in turn, charges the hybrid battery pack. This is where the comment "regeneration" or "reclaiming energy" comes from.

How to Store Energy in an Automobile?

- 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.

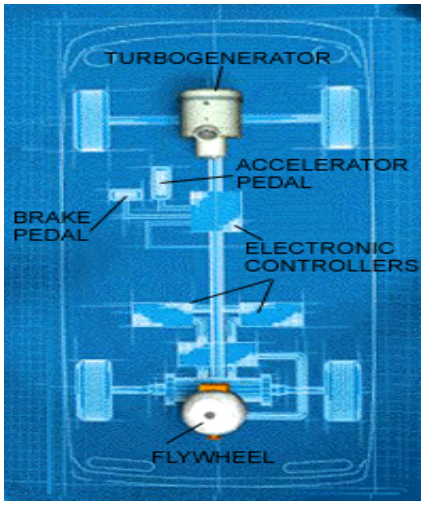

Figure 2: A Vehicle with Flywheel and Turbo-Generator

How does a Motor/Generator Work in a Hybrid/Electric Vehicle?

No matter the vehicle design there must be a mechanical connection between the M/G and the drive train. In all electric vehicles there could be an individual M/G at each wheel or a central M/G connected to the drive train through a gear box. In hybrid the motor or generator could be an individual component that is driven by an accessory belt from the engine (much like an alternator on a conventional vehicle) this is how M/G system works. It could be a pancake M/G that

is bolted between the engine and transmission, or it could be multiple M/G mounted inside the transmission. In any case the M/G has to propel the vehicle as well as be driven by the vehicle in the regenerative mode.

Propelling the Vehicle with M/G

Most of the hybrid/electric vehicles use electronic throttle control system. When the pedal is pushed a signal is sent to the on board computer which further activates a relay in the controller that will send battery current through a converter to the M/G causing the vehicle to move. In a hybrid, depending upon load,battery state-of-charge and the design of the hybrid drive train a heavy throttle will also activate the internal combustion engine(ICE) for more power. Conversely, lifting slightly on the throttle will decrease the current flow to the motor and the vehicle will slow down. Lifting completely off the throttle will cause the current to switch direction in the M/G from the motor mode to the generator mode.

Regenerative Braking: Slowing Down the Vehicle and Generating Electric Power

This is really what the regenerative mode is all about. With the electronic throttle closed and the vehicle is still moving, all of its kinetic energy can be captured to both slow down the vehicle and recharge its battery. As the onboard computer signals the battery to stop sending the electricity and start receiving it, the M/G simultaneously stops receiving electricity for powering the vehicle and start sending current back to the battery for charging.

When an M/G is supplied with electricity it makes mechanical power, when it is supplied with mechanical power it makes electric power. But how does the generating electricity slows down the vehicle? Friction, its enemy of motion. The armature of the M/G is slowed by the force of inducing current in the windings as it passes over the opposing poles of the magnets in the stator. It is this magnetic friction that slowly snaps the vehicle's kinetic energy and helps to brake it.

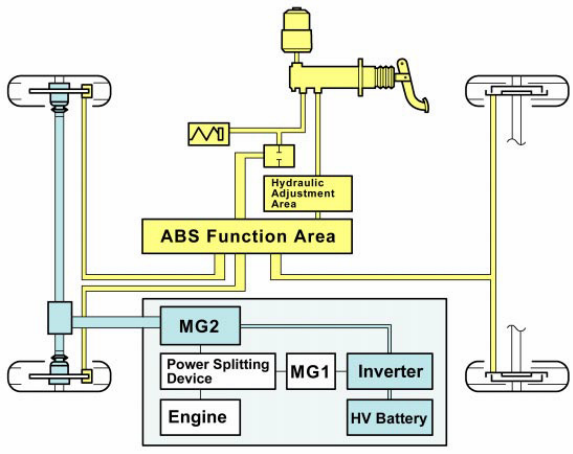

Figure 3: Circuit Showing RBS

Future of Regenerative Braking System

To increase the efficiency every automotive has to adapt regenerative braking system in it. All cars, trucks, buses and also in electrical locomotives. Besides regaining electric power it also increases the effort of braking to control the wheel from skidding. As already mentioned it increases the efficiency of the vehicle by 20-40% depending upon the motor size.

GRAPHS AND RESULTS

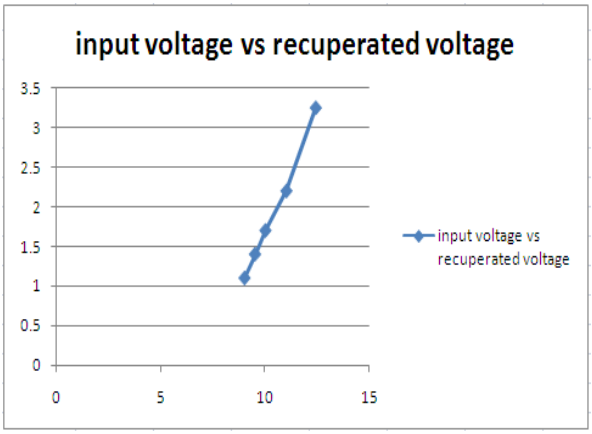

Figure 4: Input Voltage vs. Recuperated Voltage

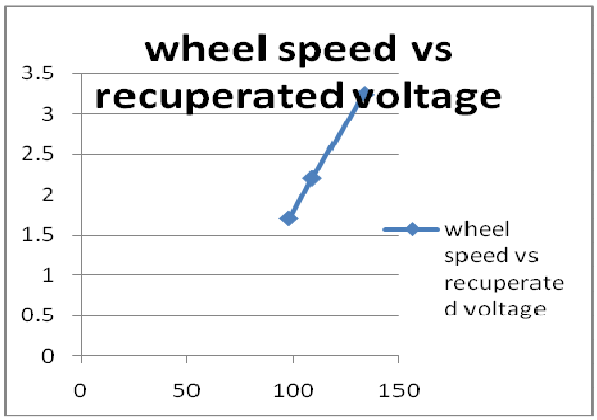

Figure 5: Wheel Speed vs. Recuperated Voltage

A graph is drawn between the input voltage and the regained voltage. The maximum energy that can be regained from this prototype is **25%** and the maximum output voltage is **3.25** Volts for an input voltage of **12.4** Volts. Also another graph is drawn between the wheel speed in rpm and recuperated voltage**.**

SCOPE FOR FUTURE WORK

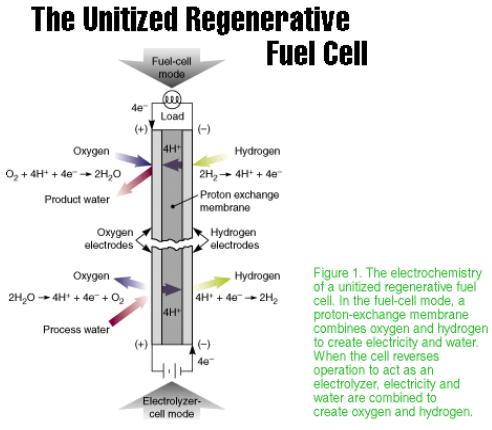

Figure 6: Unitized Fuel Cell

The above figure is a unitized fuel cell where in the fuel cell mode the proton exchange membrane combines oxygen and hydrogen to produce electricity and water. When the cell reverses operation to act as electrolyzer, electricity and water are combined to produce hydrogen and oxygen.

The above technology can be possible in a hybrid regenerative braking. RBS is a forth coming technology which can be extensively used in every automobile which accounts for the downfall of pollution and increase the life pack of the battery by frequent braking which takes place while vehicle is running.

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