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Regenerative Braking: Review Paper

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Abstract:- A brief review of research in theRegenerative braking system is presented. The regenerative braking system isan energyretrieval mechanism which stops a moving vehicle or object by converting its kinetic energy into electrical energy and store it in batteries or capacitors. When conventional brakes are applied, kinetic energy is wasted into heat energy due to friction between the brakes and wheels. This heat is carried away in the environment 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. The aim of this project was to store the energy which is wasted during braking, and monitor it over a display. An Electric Motor is a device which is used to convert this Kinetic Energy into electrical energy.It increases the efficiency of the electric vehicle by saving the energy.

Keywords: *Regenerative braking system, Conventional brakes, Energy Recovery Mechanism, Electric motors.*

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I. INTRODUCTION

A. Convectional Braking System: The application of the brakes is done to stop the vehicle which is in motion. The distance between the time the brakes are applied and the time the vehicle comes to complete rest is known as the braking distance. Friction is used to antagonize the forward momentum of a moving vehicle in conventional vehicles braking. When the brake strains against the wheels, a large amount of heatis created, which is dissipated into the environment, vehicle's25 to30 percent generated power is dissipated into heat everytime the brakes are applied. The vehicle's fuel efficiency is reduced. Thus,

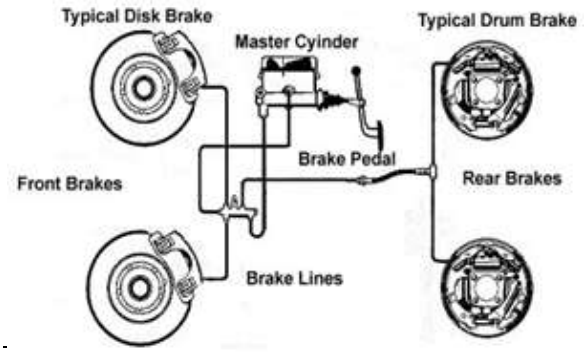

Figure1: A Conventional Braking System.

More energy is required to supplant the energy that was wasted due to conventional braking to the vehicle.

B. Regenerative Braking System: Energy is wasted when the brakes are applied every time. As the brakes are applied and the vehicle comes to rest, the kinetic energy that was moving it in the forward direction gets released in the form of heat and is wasted into the environment. This energy, that could have been used to do work, is basically wasted. The Regenerative Braking System is a methodto such kind of situation.This method of the braking system is capable of recollecting some amount of the vehicle's kinetic energy which is generally lost as heat energy and convert it into electrical energy that can be stored.

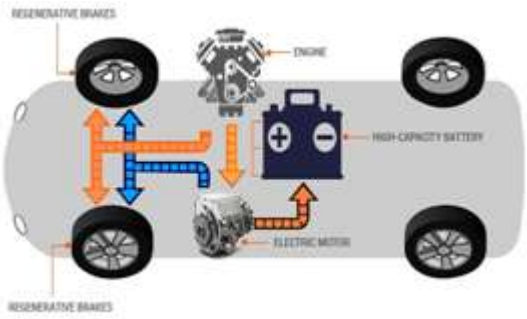

Figure 2: An exampleregenerative braking system.

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This technology of automotive industry is emerging rapidly and can prove to be very beneficial. The regenerative braking technology results in the regaining of the energy and alsoimprovesthe efficiency of the vehicle and saves the restored energy in the auxiliary battery.

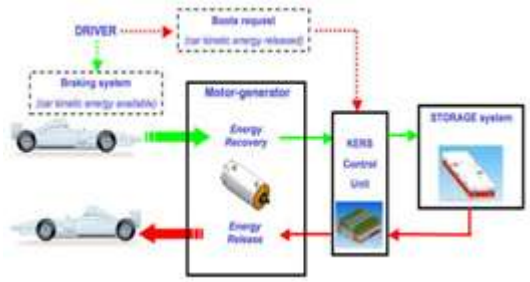

Figure 3: Block Diagram of Regenerative Braking

There are many events of application of breaks while driving an automobile, because of which great energy losses occur, vehicles such as cars, taxis, buses, delivery trucks, trains, bicycles and so on there are, theevengreater potency of restoring the energy. The amount of work done by the engine is reduced, and thus the amount of energy needed to drive the vehicle. Energy is generally wasted in the process of braking, is directed by a power transmitting system to the battery during retardation. This restored energy can be consumed back as kinetic energy whenever the vehicle needs the acceleration.

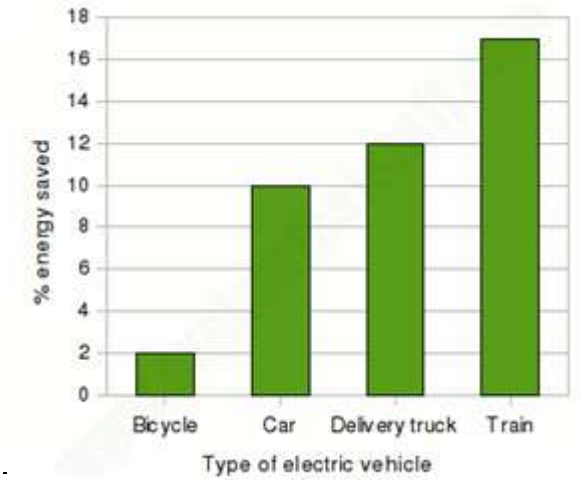

Figure 4: Relation between the amount of energy saved to the type of vehicle used.

The amount of the energy storage differs accordant with the type of auxiliary storage, driving vehicle efficiency, drive cycle time and inertial weight of the vehicle. At lower speeds, regenerative brakes are less effective when compared to the vehicles at greater speeds. Thus, the conventional brakes are required in a state when regenerative brake fails, to bring the vehicle to complete rest.

II. KINETIC ENERGY TO ELECTRICAL ENERGY CONVERSION

An electric motor, used as an electric generator, is the most common form converting kinetic energy to electrical energy. Its working principle depends upon the working of an electric motor. When electrical current or voltage is provided to the electric motor, it converts electrical energy into mechanical energy. But, when some external force in the form of mechanical energy is applied to the motor, it operates as a generator and creates electricity instead of consuming it.

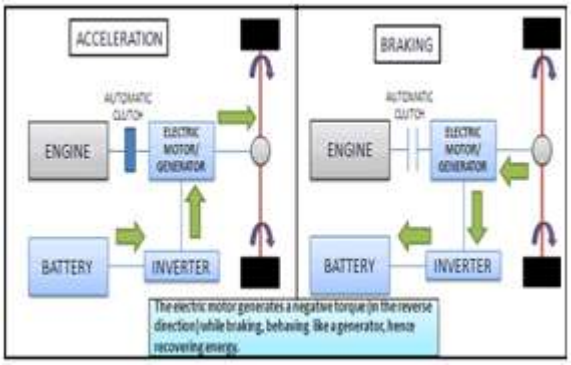

Figure 5: Flow of energy during the process of acceleration and deceleration.

The rotating torque of the driving axle is used to rotate the electric motors, which produces regenerating electric energy that can be stored in the battery and decreasing the speed of the vehicle at the same time due to the electric motors the regenerative resistance.

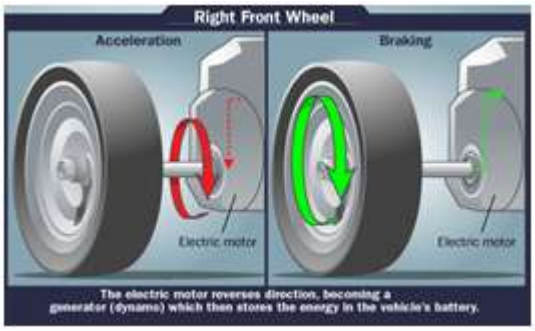

Figure 6: Electric motor as Electric generator.

III.THE EFFICIENCY OF AREGENERATIVE BRAKING SYSTEM

The energy efficiency of a vehicle depends upon the factors such as the weight of the vehicle, the aerodynamics of the vehicle, gearing and engine of the vehicle, and so on. In the case of cars, only about 20 percent of energy is restored,

with the rest of 80 percent of this energy is wasted as heat energy whereas, in the case of hydraulic regenerative braking systems, it is observed upto 25 to 45 percent. Hybrid vehicles can travel remarkably farther per gallon of fuelwith electric motors and regenerative brakes, several achieving more than 50 miles per gallon(around 23kilometer per hour).

IV.APPLICATIONS

- Kinetic energy recovery mechanism.
- Regenerative braking systems are used in electric elevators and crane lifting motors.
- Also used in electric and hybrid cars, electric railway vehicles, electric bicycles, etc.
- Could be used in an industry that uses a conveyor system to move material from one workstation to another and halts at acertain distance after a prescribed interval.

V. ADVANTAGES

- Better Performance.
- Cuts down on pollution related to supply generation.
- Efficient Fuel Economy–The fuel consumption is reduced, dependent onthe machine cycles, vehicle design, automation controlplan, and the individual component's efficiency.
- Reduced wear and tear ofEngines.
- Reduced Brake Wear– Cutting down the replacement brake linings cost, the cost of labor for installation, and machinedowntime.
- Reduced emissions–Cuts down on pollution related to power generation, engine decoupling reduces the total number of revolutions and thus engine emissions.
- Smaller accessories – downsizing fuel tank and thus the weight of the vehicle.

VI. LIMITATIONS

•In practice, the regenerative brakes take thetime to slow down a vehicle,hencemost of the vehicles that use them, also have friction brakes working alongside. This is one reason why regenerative brakes don't save 100 percent of braking energy.

- High cost of components, engineering, and installation.
- As compared to dynamic brakes, regenerative brakes areneededto match the power producedby the input supply(D.C. and A.C.supplies),and it is achieved only with the help of development of power electronics.
- A Regenerative braking safety is limited when the batteries storing the recovered energy are 100 percent charged. The excessive charge would cause the voltage of the battery to rise above a safe level.
- Added maintenance –dependent on the complexity of the design.

VII. FUTURE SCOPE

A further research is required in the field of regenerative braking systems to develop animproved or upgraded system which is capable of restoringgreater energy and decelerates faster. In near future, with better advancements in this field by the designers and engineers, these systems will become more and more common. By recapturing the energy that is generally lost during the braking process, all moving automobiles can profit from these systems. The future technologies will contain new upgraded types of motors and generators, that will be highly efficient, better designs, less prone to energy losses. It is expected that the future technologies have more potential of improved vehicle efficiency.

CONCLUSION

The energy lost during the braking is conserved by the regenerative braking system. These systems canwork at the high-temperature ranges and are highly efficient when compared to the conventional brakes.Regenerative brakes are more effective at higher momentum. The more frequently a vehicle stops, the more it can benefit from this braking system. Large and heavy vehicles that movies at high speeds builds up lots of kinetic energy, so they conserve energy more efficiently.It has broad scope for furtheradvancements and the energy conservation. Enhances the growth of the economy.

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