Abstract

Regenerative braking systems (RBS) are an effective method of recovering the energy released and at the same time reducing the exhaust and brake emissions of vehicles. This method is based on the principle of converting the kinetic energy created by the mechanical energy of the motor into electrical energy. The converted electrical energy is stored in the battery for later use. This braking system must meet maximum energy recovery criteria by performing its function safely within the shortest braking distance. This study was conducted to provide comprehensive information about regenerative energy systems. These systems provide economic benefits via fuel savings and prevention of material loss. Their use also contributes to a clean environment and renewable energy sources, which are among the most important issues on the global agenda. It is clear that more comprehensive studies should be carried out in this area.

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 dnring 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. The magnitude of the portion available for energy storage varies according to the type of storage, drive train efficiency, drive cycle and inertia weight. A lorry on the momway could travel 100 miles between stops. This represents little saving even if the efficiency of the system is 100%. City centre driving involves many more braking events representing a much higher energy loss with greater potential savings. With buses, taxis, delivery vans and so on there is even more potential for economy. Since regenerative braking results in an increase in energy output for a given energy input to a vehicle, the efficiency is improved The amount of work done by the engine of the vehicle is reduced, in turn reducing the amount of prime energy required to propel the vehicle. In order for a regenerative braking system to be cost effective the prime energy saved over a specified lifetime must offset the initial cost, size and weight penalties of the system. The energy storage unit must be compact, durable and capable of handling high power levels efficiently, and any auxiliary energy transfer or energy conversion equipment must be efficient, compact and of reasonable cost.

History

This Technology of regen braking and energy conservation sounds unbelievably pioneering for automobiles & locomotives to come up with regen braking system, however a small percentage of investigation proves otherwise

The oldest credit for a car using a regenerative braking system that we can find is given to an EV concept car, the AMC Amitron in 1967. This car never made it to production of course, but it does show just how long it took before the technology was widely used!
Many people familiar with the Formula 1 racing series may remember the use of the KERS, or Kenetic Energy Recovery System, as early as the 2009 system.
These days regenerative braking systems are found on nearly all vehicles that have an electric motor

Working Principle of Regenerative Braking System

Regenerative braking is a braking method that provides charge to the battery by converting the mechanical energy of the motor and kinetic energy into electrical energy. In regenerative braking mode, the car's engine slows down on an incline. When force is applied to the brake pedal, the vehicle slows down and the motor runs in the opposite direction. When operating in the opposite direction, the engine acts as a generator and converts torque energy into electrical energy. In this way, fuel consumption and

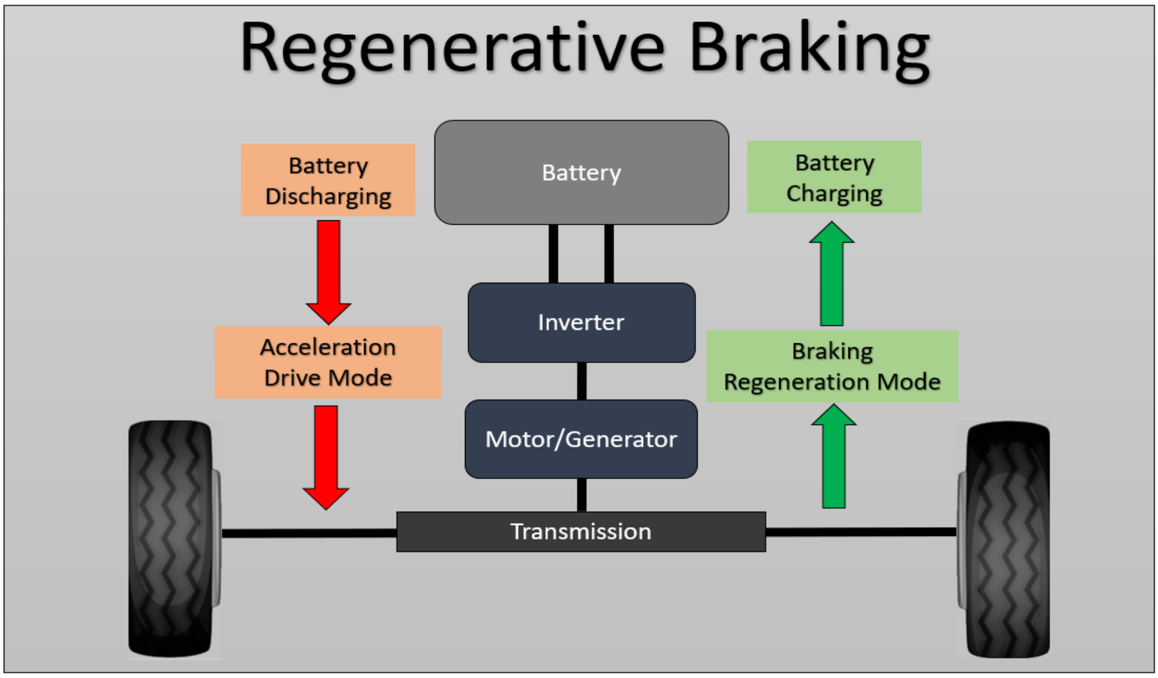
missions are reduced. In high-speed vehicles, the

braking force is lower, and therefore does not adversely

affect the traffic flow

The new electric-hydraulic powertrain is a parallel hybrid system that includes a traction motor, battery pack, hydraulic pump / motor (secondary component), hydraulic accumulator, reservoir, and a set of hydraulic valves. The hydraulic circuit includes the drive circuit and the drain circuit. The drive circuit consists of a cartridge valve, a one-way valve, and a two-position four-way valve. When the vehicle is braking, the valve is shifted to the left; this directs the oil from the reservoir to flow towards the accumulator using the secondary component pump / motor. The secondary component operates in pump mode, using the kinetic energy of the vehicle to pressurize the oil in the reservoir to flow into the accumulator. The energy is stored in the accumulator and the vehicle slows down. The hydraulic system works in the regenerative braking mode These brakes work very effectively in urban braking situations. The brake system and control sensors are programmed to control all of the vehicle motors.

The brake control sensor calculates the electricity to be generated and the rotational force to be fed to the batteries by monitoring the speed and torque of the wheel. During braking, the brake control sensor controls the electrical energy generated by the motor and directs it to the batteries



Series Regenerative Braking System

The vehicle's power train includes an auxiliary power unit (APU), which consists of an internal combustion engine connected to a generator and rectifier that can start the electric motor or recharge the batteries as requested by the vehicle control unit (VCU).The electric motor controlled by the motor control unit can act as a drive motor or a generator. During regenerative braking, while the motor is operating as a generator, the battery can start the motor or absorb current from the APU and the electric motor. The framework of the RBS series consists of the RBS, the ABS and two duty valves used to adjust the friction braking force. Working valves are installed on the front and rear brake lines. Elements used in the ABS can be used for this purpose and have a rapid response time. The different states of the two valves determine the air pressure in the brake chambers. The brake control unit controls the mechanical braking force under the command of the RBS control system by sending pulse width modulation (PWM) signals to the valves to control the pressure. When the electronic control unit (ECU) detects a lock on one of the rear wheels, the ABS controller emits a signal that will cause the brakes to vibrate to activate the modulator valve, thereby easing the wheel lock state. Since the RGS is mounted on the rear axle, the same signal can be used to control the regenerative braking force and to increase vehicle stability by minimizing wheel lock during hard braking operations

Parallel Regenerative Braking System

During parallel regenerative braking, both the electric motor and the mechanical braking system always work together in parallel to slow down the vehicle [56]. Energy regeneration during braking is important for a parallel HEV because it enables the vehicle to improve fuel economy and extend its driving range. To increase energy use during braking, the electric motor applies a negative torque to the wheels to convert some of the vehicle's kinetic energy into electrical energy to recharge the battery

Since the mechanical braking process cannot be controlled independently of the brake pedal force, some of the kinetic energy of the vehicle is converted into heat, not electrical energy. The regenerative braking force developed by the electric motor is a function of the hydraulic pressure of the master cylinder and therefore a function of vehicle deceleration. Since the available regenerative braking force is a function of the motor speed and almost no kinetic energy can be recovered at low motor speeds, in order to maintain brake balance, the regenerative braking force is designed to be zero at high-speed deceleration. A pressure sensor detects hydraulic pressure indicating the demand for deceleration in the master cylinder. The pressure signal is regulated and sent to the electric motor controller to control the electric motor in producing the desired braking torque. Moreover, the parallel regenerative braking system is simple and inexpensive. With this method, the electric motor can be integrated into the system with a small modification on the mechanical brake system. In addition, there is the advantage of always having a back-up mechanical brake system in cases where repeated brake system failure occurs

Conclusions

This study presents information about the principles and properties of regenerative braking systems. Many automation, electromechanical, and constructive studies have been carried out in this field in order to boost recovered energy efficiency and reduce operating costs. Considering that most of the economic losses worldwide are caused by mechanical wear, the importance of regenerative braking systems has become better recognized. Safety, comfort, and economic aspects can be increased by developing these brake systems. Regenerative braking systems, currently in limited use in electric vehicles, can also be used in conventional braking or other motion control systems. When they are widely used, economic input can be obtained by the reduction of mechanical losses and energy savings can be achieved as a result of the recovered electrical energy. In addition, vehicle emissions caused by conventional brake wear can be reduced, thus contributing to the protection of the environment and human health. As a result, these systems emphasize the recovery of energy, reduction of energy consumption, lowering of costs, and provision of clean air. For this reason, more comprehensive studies in the field of regenerative braking systems should be carried out and their findings presented to policy makers and researchers

References

1. Tengat-Sing-h ofstudent of