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Introduction to HV by Using Regenerative Braking System

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ABSTRACT

A **'gasoline-electric hybrid car'** or **'HEV'** is a vehicle which runs on batteries as well as on the internal combustion engine which drive a generator cum motor to provide the electricity and also the vehicle. It has great advantages over the previously used gasoline engine that drives the vehicle from gasoline only. It is also a major source of air pollution. The objective is to design and fabricate a HEV powered by battery and gasoline both. The combination of power makes the vehicle simple in nature and efficient. It provides its owner with advantages in fuel economy.

HEVs combine an electric motor, battery and power system with an internal combustion engine to achieve better fuel economy and reduce the pollution emissions. In HEV, the battery alone provides power for low-speed driving conditions where internal combustion engines are less efficient. In long highways, or hill climbing the electric motor provides additional power to assist the engine. Thus a smaller, more efficient engine can be used. Besides it also utilizes the concept of regenerative braking for optimized utilization of energy. Energy dissipated during braking in HEV is used to charge the battery. Thus the vehicle is best suited for growing urban areas with high traffic.

KEYWORD

Regenerative braking system, plug in hybrid, series and parallel hybrids, Supervisory Control, Four wheel drive

INTRODUCTION

Ferdinand Porsche in 1901 developed the Lohner-Porsche Mixed Hybrid, the first gasoline electric hybrid automobile in the world. The hybrid-electric vehicle did not become widely available until the release of the Toyota Prius in Japan in 1997, followed by the Honda Insight in 1999 While initially perceived as unnecessary due to the low cost of gasoline, worldwide increase in the price of petroleum caused many automakers to launch hybrids in the late 2000s; they are now perceiving it as a core segment of the automotive market of the future.

A HEV is a combination of gasoline or diesel vehicle and electric vehicle which combines a conventional internal combustion engine with an electric motor to obtain the maximum fuel efficiency. This combination offers the extended range, thus avoiding frequent refueling that consumers expect from a conventional vehicle, with a significant portion of the energy and environmental benefits of an electric vehicle. The practical benefits of HEVs include improved fuel economy and lower emissions of the full host of criteria pollutants, as well as CO2, compared to conventional vehicles.

Modern HEVs make use of efficient technologies such as Regenerative Braking, which converts the kinetic energy of vehicle into electric energy to charge the battery, rather than wasting it as heat energy by conventional braking system. Some type of HEVs use their internal combustion engine to generate electricity by rotating an electrical generator to generate the electricity and recharge the batteries or to directly power the electric motors. Many HEVs reduce idle emissions by shutting down the IC engine at idle and restarting when it is needed this is known as a start-stop system. A HEV produces less emissions from its IC engine as compared to the normal gasoline car, therefore in HEV the engine is comparatively smaller in size than normal gasoline car.

CONSTRUCTION

HEV consist of an electric storage device such as battery and ultra-capacitor. They also combines the energy storage source with a mechanical device are internal combustion engine, fuel cell. This combination reduces both fuel consumption and flue emission.

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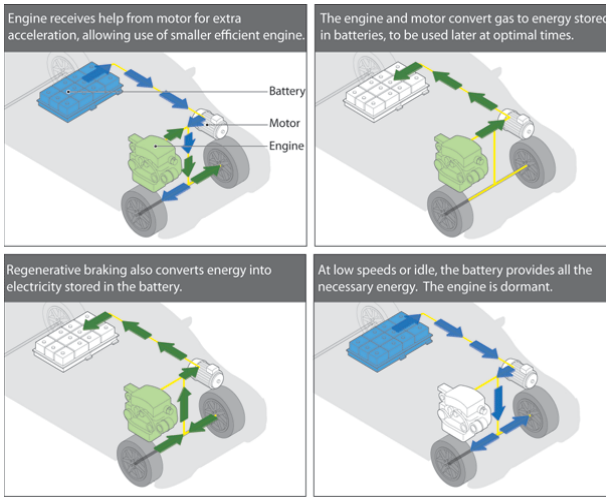

Figure 1; show the construction of HV with regenerative braking system

The HV serves several advantages over pure electric vehicle as HV engine shares the workload with electric motor. It allows the construction of a smaller engine hence reducing the weight, giving good fuel economy. Also HEV engine can be optimized to operate within the specific speed range characterized by better fuel economy and reducing emissions. This increases the fuel economy.

One of the most important advantages of HV is regenerative braking system. In which powertrain converts stored energy into vehicle motion moreover, it converts vehicle motion back into stored energy through the use of regenerative braking. Regenerative braking system provide vast benefits and estimated 60% of the total energy consumption in urban driving is spent for overcoming the effect of inertia. Means half of energy may be recovered in HEV.

The HV contain the following main parts that is

1) Battery
2) Internal combustion engine
3) Generator
4) Power split device
5) Electric motor

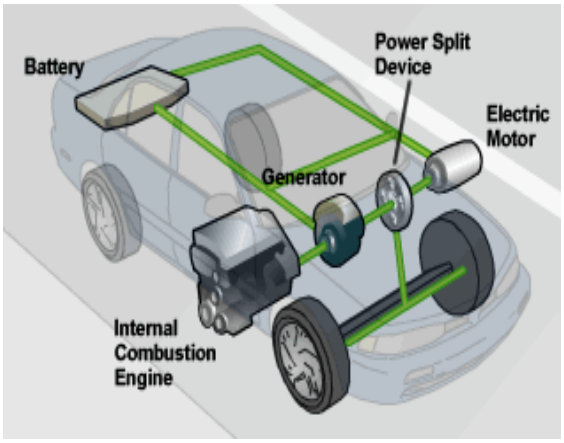

Figure 2: the parts of HEV

BATTERY

The batteries in a hybrid car are the energy storage device for the electric motor. Unlike the gasoline in the fuel tank, which can only power the gasoline engine, the electric motor on a hybrid car can put energy into the batteries as well as draw energy from them.

INTERNAL COMBUSTION ENGINE (ICE)

The hybrid car has an ICE, also known as a gasoline engine, much like the ones found on most cars. However, the engine on a hybrid is smaller and uses advanced technologies to reduce emissions and increase efficiency. Receives its energy from the fuel tank where the gasoline is stored.

GENERATOR

The generator is similar to an electric motor, but it acts only to produce electrical power for the battery.

POWER SPLIT DEVICE

The power-split-device resides between the two motors and together with the two motors creates a type of continuously variable transmission.

ELECTRIC MOTOR

The electric motor on a hybrid car acts as a motor as well as a generator. For example, when needed, it takes energy from the batteries to accelerate the car. But acting as a generator, it slows the car down and returns energy to the batteries.

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WORKING

The HEV work and constructed in two ways are,

1) Series HV
2) Parallel HV

SERIES HV

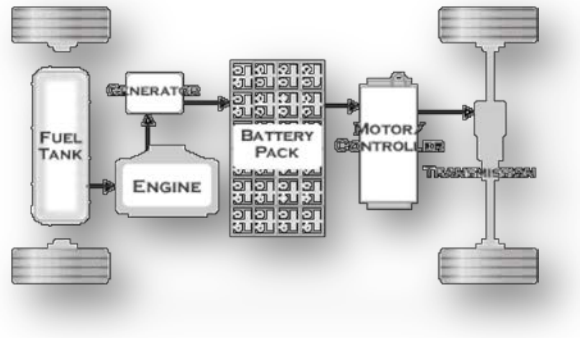

Figure 3(A) schematic of a series hybrid propulsion system

In a series hybrid the IC engine runs an electric generator which produces electricity to charge batteries. The batteries drive the electric motor to run the vehicle – the arrangement is similar in principle to well-known diesel-electric locomotives. Since the engine does not `see' the wheel, it can be made to run at an optimized operating condition (best in terms of fuel efficiency and emissions). The DC motor driving the wheel can take care of all vehicle speed changes. It is also possible to charge the batteries by connecting to external grid power, and depending on the storage capability of the batteries the vehicle can run in a purely electric mode for certain distances with the IC engine started only when the batteries are almost discharged.

PARALLEL HV

In a parallel hybrid, the power can flow in parallel to the wheels from either the batteries or the IC engine. An electronic controller can sense the load and speed of the wheel/vehicle and using built-in algorithms, the power can be made to flow either from the batteries or the IC engine or from both. In most urban driving (especially in crowded and narrow streets in less developed countries), the peak speed or power is rarely required. In such situations, the parallel hybrid can be configured in a way such that most of the time, the vehicle runs on batteries resulting in low emissions and high fuel efficiency.

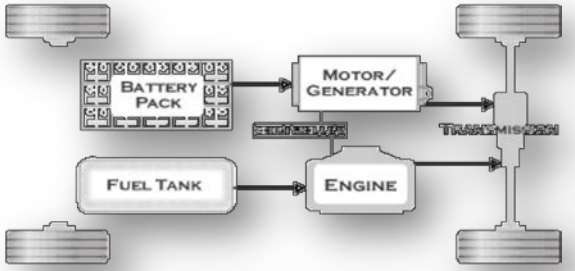

Figure 3(B) schematic of a parallel hybrid propulsion system

Only when required, power can be added to the wheels from the IC engine. In this framework, the IC engine, the batteries and generator, and the electric motor individually need not to be designed to meet peak requirements. This makes a parallel hybrid configuration potentially cheaper. There is the added complication of designing power trains where power can be added and use of an electronic controller. The basic parallel hybrid architecture of figure is often implemented in several ways. Figure shows how a parallel hybrid propulsion system can be implemented.

REGENERATIVE BRAKING SYSTEM

When braking in a conventional vehicle, the friction brakes converts much of the kinetic energy into heat that is emitted unused into the environment. HV with regenerative braking system are different in that they recover some kinetic energy by the electric motor and store it as an electric energy in a high voltage battery. This process known as regenerative braking. The electric motor can use this stored energy when driving or accelerating.

Regenerative braking makes it possible to increase the range of electric vehicle and reduces the fuel consumption and carbon footprint of HV.

When braking in the HV the electric motor switches to generator mode. The wheel transfer kinetic energy via the drivetrain to the generator. The generator turns in a similar way to a bicycle light generator transfer part of kinetic energy into electrical energy which is then stored in a high voltage battery at the same time generator resistance produced from the electricity generated slows the vehicle. When more braking torque is required then additional braking is provided by frictional brakes.

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In many situation the generator braking power is sufficient to slow the vehicle as desired by the driver as a result the friction brakes is used less often for example in instances of very rapid deceleration at very low speed and stationary regenerative braking contributes toward increasing the range of electric vehicle it help to save fuel in HV and to reduce emission of CO_2 and pollutants particularly in urban traffics situation involving frequent braking and acceleration using the generator for braking also reduces brakes wear and the buildup of brakes dust.

Regenerative braking system controls the interaction between frictional brakes and the generator to generate efficient energy. Recuperation they also ensure that deceleration behavior and pedal feel are identical to conventional braking system.

The generator braking potential is dependent on the engine driving speed. At low engine speed maximum braking torque is available. At high or very low speed, sufficient braking torque cannot be provided meaning the friction brakes must be activated. Generator brakes torque is proportional to the generator output and is also influenced by the battery level of charge. Brake torque from the generator is only available when the high voltage battery is not fully charge.

Brake torque is distributed between the frictional brakes and generator taking safety comfort and efficient criteria into consideration. If the vehicle becomes unstable. It is usually decelerated safely via the friction brake as wheel specific invention of the antilock braking system or electronic stability program.

CONCLUSION

HEV is a vehicle that uses two sources of power- gasoline and battery. For low power application battery drive is used whereas for high power application where power requirement is very high gasoline engine is used. Gasoline drive is most efficient at high speed drive. Thus HEV's both mode of operation occurs at their maximum efficiency. But in gasoline engine low speed operation is not efficient. Its high speed mode is only efficient. Therefore, it gives twice the mileage given by a normal vehicle. As this HV emits 50% less emission than normal vehicle it plays an important role for reducing pollution to certain extent without compromising with efficiency. Thus it is most efficient in urban areas mainly in high traffic where gasoline engines are least efficient as the energy from gasoline is being wasted away and creates pollution.

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