

HYBRID ELECTRIC VEHICLE

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ABSTRACT

In this modern world Pollution is one of the major problem which ultimately leads to global warming, acid rain and many other hazardous environmental problems. Pollution is basically caused due to the excessive use of conventional electric vehicle, this problem can be overcome by the use of Hybrid electric vehicle (HEV's). As Hybrid Electric Vehicle combines the benefits of gasoline engines and electric motor and can be configured to obtain different objectives, such as improved fuel economy, increased power or additional auxiliary power for electronic devices and power tools, it also involves advanced technologies such as Regenerative braking, Electric motor drive assist, automatic start and shut off. The internal combustion engine of HEV's are much smaller, lighter and efficient therefore have better mode of operation and produces less emissions compare to ordinary electric vehicle. This paper provides information regarding Hybrid Electric Vehicle which is the modified form of electric vehicle involves advanced technologies which helps in minimization of Pollution.

Key words: *Hybrid electric vehicle, series hybrid, Parallel hybrid, plug-in hybrid electric vehicle*

I. INTRODUCTION

1.1 Hybrid Electric Vehicle

HEV's is type of electric vehicle which combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. The presence of electric power train is intended to achieve better fuel economy or better performance.

The most common form of HEV's are:-

- Hybrid electric cars of Toyota and Honda (for example TOYOTA PRIUS)
- Hybrid electric buses/Trucks

1.2 Series Hybrid

It is the configuration in Hybrid Electric Vehicle which internal combustion engine and electric motor are connected in series and electric motor drives the drive train and the internal combustion engine works as a generator to power the electric motor or to recharge the batteries. The battery pack can be recharged through Regenerative Braking or by the internal combustion engine. Series hybrids usually have a smaller combustion engine but a larger battery pack

as compared to parallel hybrid. This hybrid basically uses batteries (rather than the internal combustion engine) as the primary sources of power of the wheels. As shown in fig 1

1.3 Parallel Hybrid

It is the configuration in Hybrid Electric Vehicle in which internal combustion engine and electric motor both are connected in parallel and mechanically coupled, and simultaneously transmit power to drive the wheels, usually through conventional transmission. The parallel hybrid can also utilize the engine to charge the battery pack during less intense power driving cycles, such as cruising at freeway speeds. In a parallel hybrid it is possible to turn the engine off and run the electric motor from the battery pack for shorter in-town driving. In this case, the Parallel hybrid acts as a fully electric vehicle and becomes virtually emissions free. The driving range of a Parallel Hybrid can achieve up to 400 miles or more.

Honda Insight and Honda civic hybrid cars which are examples of Parallel Hybrid as shown in fig.2

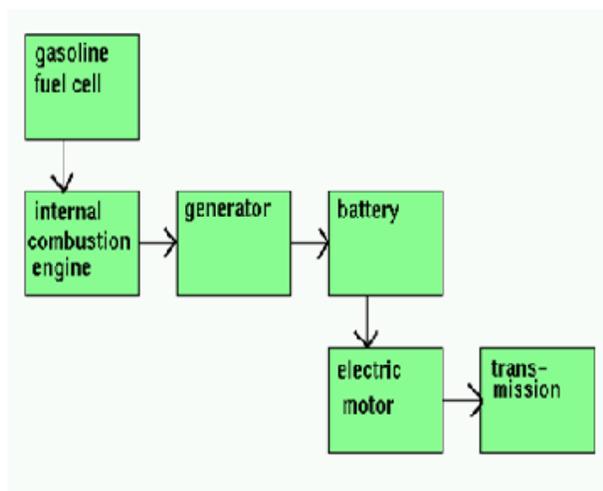


Figure1: SeriesHybrid

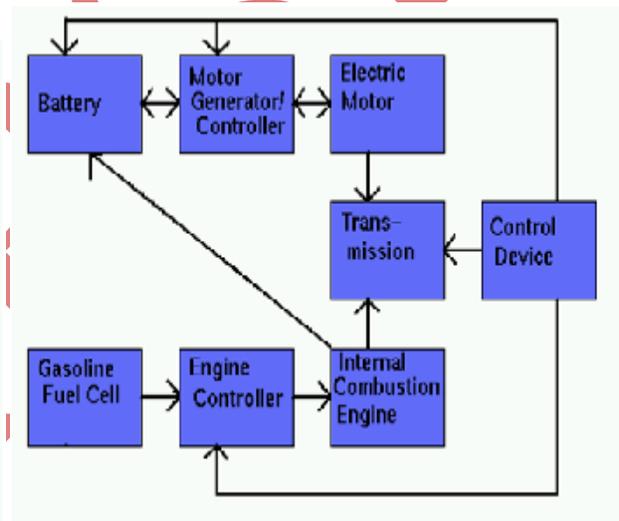


Figure 2: Parallel Hybrid

1.4 Plug-In Hybrid

Electric vehicle which utilizes rechargeable batteries or another energy storing device that can be restored, to full charge by connecting a plug to an external electric power sources (Usually a normal wall socket). Plug –in Hybrid Electric Vehicle recover more kinetic Energy during Regenrative Braking thereby increasing fuel efficiency as shown in fig. 3. The Benefits and Challenges of PHEV's are following:

- **Less Petroleum Use.** PHEVs are expected to use about 40 to 60 percent less petroleum than conventional vehicles. Since electricity is produced primarily from domestic resources, PHEVs reduce our dependence on oil.

- **Less Greenhouse Gas (GHG) Emissions.** PHEVs are expected to emit less GHG than conventional vehicles, but the amount generated depends partly on the fuel used at electrical power plants—nuclear and hydroelectric plants are cleaner than coal-fired power plants.
- **Higher Vehicle Costs, Lower Fuel Costs.** PHEVs will likely cost \$1,000 to \$7,000 more than comparable non-plug-in hybrids. Fuel will cost less since electricity is much cheaper than gasoline, but it is unclear whether fuel savings will offset the vehicle cost when PHEVs are first introduced. Federal tax incentives up to \$7,500 are currently available for qualifying PHEVs.
- **Re-charging Takes Time.** Re-charging the battery typically takes several hours, but a "quick charge" to 80% capacity may take as little as 30 minutes. However, PHEVs don't have to be plugged in to be driven. They can be fueled solely with gasoline but will not achieve maximum range or fuel economy without charging.
- **Measuring Fuel Economy.** Since a plug-in can operate on electricity alone, gasoline alone, or a mixture of the two, EPA provides a fuel economy estimate for gasoline-only operation and an estimate for electric-only or gas and electric operation. These estimates are for combined city-highway driving; separate estimates for city and highway driving are not provided.

II. EVOLUTION OF HYBRID ELECTRIC VEHICLE

When a young Ferdinand Porsche took a job as a coach-builder near the turn of the 20th Century, he began a process that was to lead to the development of hybrid cars and provide a serious alternative to oil-fuelled combustion engines. While fuel-guzzling Porsches have fascinated the minds of petrol-headed fans the world over for many decades, now the Lohner Porsche Mixte Hybrid developed in 1900, which was the first gasoline-electric hybrid car in the world, is now being re-evaluated due to the inherent simplicity of his original design. It is what is part and parcel of what is at the heart of what is being manufactured today. His invention was essentially an electric vehicle which combined a conventional internal combustion engine system with an electric propulsion system. One of the main reasons for the mothballing of this hybrid car was due to the invention of the internal combustion engine and its reliance on refined oil to generate its mobility. Suddenly the car provided people with a freedom they had not experienced before and, as oil appeared to be quite plentiful, car manufacturers were happy to keep designing new models fuelled by plentiful supplies of oil. Oil was cheap and seemingly available in inexhaustible amounts, and at that time, the green movement was non-existent up until the early 1980s. This alone, to a large degree, is why there had been no real demand for hybrid cars. A further reason for this lack of demand was due to the low priority given to the design quality of these vehicles. Recently, a British made prototype hybrid car appeared on E-bay, dating from the early 1980s. It was described as "a unique, one-off hybrid electric car...this vehicle represents the pinnacle of hybrid electric design" Indeed, the facts and figures seemed quite impressive. It had a top speed of 85mph, with 75mph when running solely on electricity. It had 4 modes of operation: battery only, series hybrid mode, engine only, and parallel mode. Its battery range of 40-50 miles would have made it ideal for urban driving. You get the

feeling, though, that it was nothing more than a motorized bathtub made for collectors and connoisseurs and was not designed with the mass car market in mind.

Poor design or poor aesthetics have been one of the major factors manufacturers have had to overcome by dressing-up the appeal of hybrids for the general driving public. That's not to say all conventional cars have been gems in the good-looks department. It has definitely been the case though, that hybrid cars have always had to fight that much harder to get noticed amongst the established automotive manufacturers and their flashy combustion powered cars, while designers of hybrid Vehicles have tended to overlook what the car actually looked like, in favor of what goes on under the bonnet. However, after 100 years of stagnation, the hybrid revolution is now well and truly underway and setting new standards in the marketplace.

III. CONSTRUCTION OF HYBRID ELECTRIC VEHICLE

The construction of HEV's involves the following elements as shown in fig. 4



Figure: 3 Plug-in Hybrid

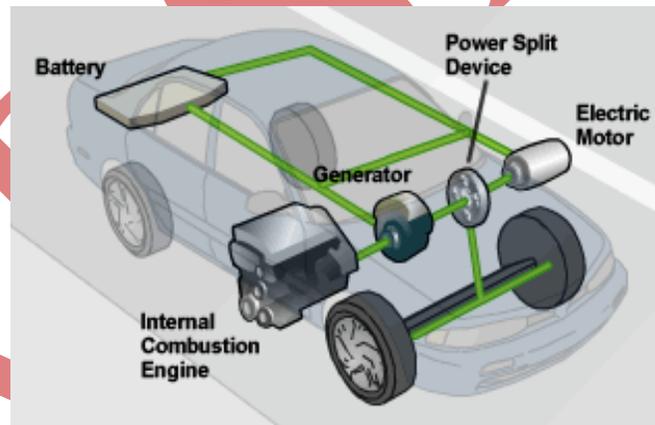


Figure 4: Hybrid Electric Vehicle

- **Internal Combustion Engine:** ICE provides main power to whole of the vehicle which drives the generator to provide electricity and also drive the wheels, ICE are much smaller, lighter and more efficient than the engine in the Conventional vehicle. Due to these ICE's only HEV's are producing less emission use about 50% less fuel than average new vehicle.
- **Generator:** It converts the mechanical energy obtain by the ICE into electrical energy and recharges the battery, and it is also connected to sun gear of the gear set in the power split device.
- **Batteries:** Individual cells originally contained liquid potassium hydroxide, The liquid is almost totally absorbed by the paper membranes inside each cell of the battery, Because the liquid is absorbed these batteries are considered "dry cell" batteries. The Ni-MH batteries are recharged through a process call regenerative braking ,Regenerative braking takes energy from the forward momentum of the vehicle and captures it while coasting or braking. Occasionally batteries are recharged by the electric motor.

- **Power Split Device:** It is a planetary gear set that removes the need for traditional stepped gearbox and transmission components .It is considered as the heart of HEV's .This is a clever gearbox that hooks the gasoline engine, generator and electric motor all together. It allows the vehicle to operate in parallel or series hybrid .It also acts as a continuously variable transmission (CVT), eliminating the need for a manual or automatic transmission. Finally, because the power split device allows the generator to start the engine, the car does not need a starter. The electric motor is connected to the ring gear of the gear set. It is also directly connected to the differential, which drives the wheels. So, whatever speed the electric motor and ring gear spin at determines the speed of the car. The generator is connected to the sun gear of the gear set, and the engine is connected to the planet carrier. The speed of the ring gear depends on all three components, so they all have to work together at all times to control the output speed. When you accelerate, initially the electric motor and batteries provide all of the power. The ring gear of the power split device is connected to the electric motor, so it starts to spin with the motor. The planet carrier, which is connected to the engine, is stationary because the engine is not running. Since the ring gear is spinning, the planets have to spin, which causes the sun gear and generator to spin. As the car accelerates, the generator spins at whatever speed it needs to in order for the engine to remain off.
- **Electric Motor:** It changes electrical energy into mechanical energy and delivers this mechanical power to wheels which moves the drivetrain, it also provides additional power when needed such as accelerating and passing. In the process of regenerative braking, the electric motor changes into generator and kinetic energy of vehicle changes into electrical energy which recharges the battery.

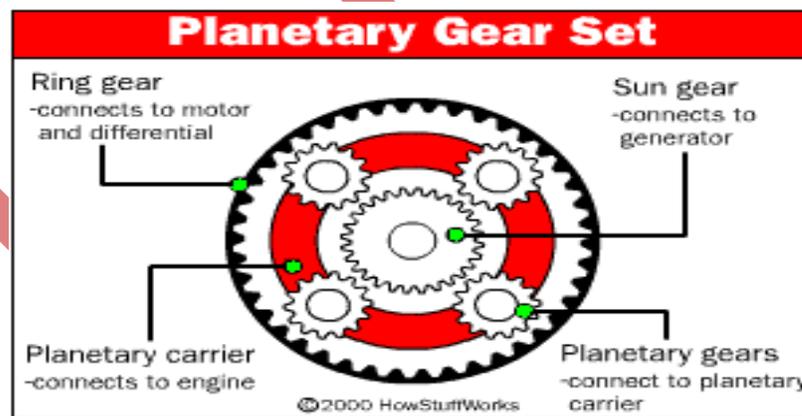


Figure 5: Planetary Gear Set

3.1 Working Principle

ICE (Internal combustion engine) provides the mechanical power to the generator ,Generator changes mechanical energy into electrical energy which is used for recharging the battery, Generator is connected to electric motor through power split device which acts as a continuously variable transmission (CVT).The electric energy coming from generator converts into mechanical with the help of electric motor,finally this mechanical power is delivered to wheels and vehicle attains the running condition.

3.2 Advance Technologies involved in the HEV's

- **Regenerative Braking.** The electric motor applies resistance to the drive train causing the wheels to slow down. In return, the energy from the wheels turns the motor, which functions as a generator, converting energy normally wasted during coasting and braking into electricity, which is stored in a battery until needed by the electric motor. Electric Motor Drive/Assist. The electric motor provides additional power to assist the engine in accelerating, passing, or hill climbing. This allows a smaller, more efficient engine to be used. In some vehicles, the motor alone provides power for low-speed driving conditions where internal combustion engines are least efficient.
- **Automatic Start/Shutdown.** Automatically shuts off the engine when the vehicle comes to a stop and restarts it when the accelerator is pressed. This prevents wasted energy from idling.

IV. CONCLUSION

HEV technology for both light and heavy duty applications is commercially available today and demonstrates substantial reductions in tail-pipe emissions and fuel consumption, even when compared to other available low emission technologies. HEVs are particularly effective for urban travel, significantly lowering pollutant emissions and providing cost-effective CO₂ reductions in personal mobility. Encouraging hybridization of vehicle fleets through enabling policies and incentive structures can serve to lower both conventional and CO₂ emission, thus improving public health, energy security, and reducing fuel costs. Continuing innovation in hybrid technology and a growing demand for cleaner vehicles will mean that costs are likely to fall, particularly in second hand vehicle markets. HEV technology, albeit more expensive than conventional vehicles, is poised for entry into new markets. This will present a number of opportunities and advantages, given that the right policies and complementary standards (including fuel quality standards) are in place and policy makers, industry groups, consumers, and vehicle maintenance providers are sufficiently informed and have realistic expectations of HEV technology. It is also important to consider that HEVs are not the only clean vehicle option available today. Cleaner diesel vehicles, compressed natural gas (CNG) vehicles, and vehicles that run on liquid biofuel blends are also viable alternatives for reducing air pollution and greenhouse gas emissions. In addition, HEVs are not necessarily fuel specific; this technology is versatile and can be applied to CNG, diesel, and flexi fuel vehicles.

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