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Survey on Hybrid Electric Vehicle

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Abstract — **Hybrids that can't be recharged from an outlet aren't generally considered to be electric vehicles, as they rely exclusively on gasoline or diesel for energy. Plug-in hybrids, described below, are considered electric vehicles, along with battery electric and hydrogen fuel cell vehicles. Hybrids that can't be recharged from an outlet aren't generally considered to be electric vehicles, as they rely exclusively on gasoline or diesel for energy. Plug-in hybrids, described below, are considered electric vehicles, along with battery electric and hydrogen fuel cell vehicles. Battery electric vehicles only use an electric motor and battery, eschewing conventional engines altogether. Because they don't use gas or diesel, battery electrics are often cleaner and cheaper to fuel than hybrids and conventional vehicles. Hydrogen fuel cell vehicles power an electric motor and battery by converting stored hydrogen gas to electricity using fuel cell. These vehicles are only beginning to come to market, but offer great potential as low-carbon alternative to conventional cars and trucks as they have no tailpipe emissions, reduced global warming emissions etc.**

Keywords- ***plug-in; batteries; style; technology; enivronmental impact;***

I. INTRODUCTION

A hybrid electric vehicle (HEV) is type of hybrid vehicle and electric vehicle that combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system (hybrid vehicle drivetrain). The presence of the electric powertrain is intended to achieve either better fuel economy than a convention vehicle or better performance. There are a variety of HEV types, and the degree to which each functions as an electric vehicle (EV) varies as well. The most common form of HEV is the hybrid electric car, although hybrid electric trucks (pickups and tractors) and buses also exist.

In 1901 Ferdinand Porsche developed the Lohner-Porsche, the first gasoline-electric hybrid automobile in the world. Research and Development was advancing in the 1990s with projects such as early BMW 5 Series(E34) CVT hybrid-electric vehicle but HEVs did not become widely available until the release of Toyota Prius in Japan in 1997, followed by Honda Insight in 1999. While initially perceived as unnecessary due to the low cost of gasoline, worldwide increases in the price of petroleum caused many automakers to release hybrids in the late 2000s; they are now perceived as a core segment of automotive market of the future.

Modern HEVs make use of efficiency-improving technologies such as regenerative brakes, which converts the vehicles kinetic energy into electric energy to charge battery, rather than wasting it as heat energy as conventional brakes do. Some varieties of HEVs use their internal combustion engine to generate electricity by spinning an electric generator (this combination is known as motor-generator), to either recharge their battery or to directly power the electric drive motors. Many HEVs reduce idle emissions by shutting down the ICE at idle and restarting it when needed; this is known as start-stop system. A hybrid electric produces less emission from ICE than a comparably sized gasoline car, since HEVs gasoline engine is usually smaller than a comparable sized pure gasoline-burning vehicle (natural gas and propane fuels produce lower emissions) and if not used to directly drive the car, can be geared to run at maximum efficiency, further improving fuel economy.

II. CLASSIFICATION

A. Types of powertrain

- **Parallel hybrids:** In parallel hybrids, the ICE and electric motor are both connected to the mechanical transmission and can simultaneously transmit power to drive the wheels, usually through a conventional transmission. The internal combustion engine of many parallel hybrids can also act as a generator for supplemental recharging. Parallel hybrids are more efficient than comparable non-hybrid vehicles especially during urban start-and-go conditions where the electric motor is permitted to continue, and during highway operation.

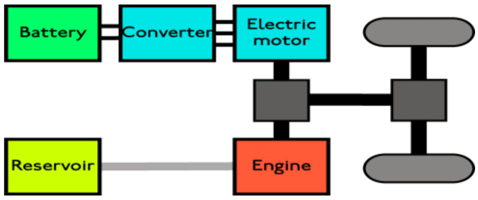

Fig 1 -Block Diagram of Parallel Hybrid

- **Series hybrids:** In series hybrids, only the electric motor drives the drivetrain and smaller ICE works as generator to power the electric motor or to recharge the batteries. In short the benefit of a series-hybrid is simplicity. The vehicle is driven only by electric traction motors with an engine/generator set providing the electric power when needed. An electric battery acts as an energy buffer that evens out demand with the stored energy used as the prime source to propel the vehicle. However when required the engine/generator can be used as a backup, to assist in acceleration, or when pulling heavy loads.

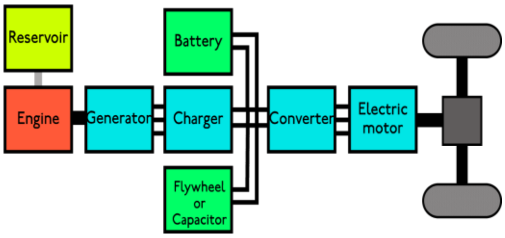

Fig 2- Block Diagram of Series Hybrid

- **Power-split hybrids**: Power-split hybrids have the benefit of a combination of series and parallel characteristics. As a result they are more efficient overall, because series hybrids tend to be efficient at lower speeds and parallel hybrids tend to be efficient at higher speeds.They incorporate power-split devices allowing for power paths from the engine to the wheels that can be either mechanical or electrical. The main principle behind this system is the decoupling of the power supplied by the engine (or other primary source) from the power demanded by the driver.

A combustion engine's torque output is minimal at lower RPMs and, in a conventional vehicle, a larger engine is necessary for acceptable acceleration from standstill. The larger engine, however, has more power than needed for steady speed cruising. An electric motor, on the other hand, exhibits maximum torque at standstill and is well-suited to complement the engine's torque deficiency at low RPMs. In a power-split hybrid, a smaller, less flexible, and highly efficient engine can be used. The conventional Otto cycle (higher power density, more low-rpm torque, lower fuel efficiency) is often also modified to a Atkinson cycle or Miller cycle (lower power density, less low-rpm torque, higher fuel efficiency; sometimes called an Atkinson-Miller cycle). The smaller engine, using a more efficient cycle and often operating in the favorable region of the brake specific fuel consumption map, contributes significantly to the higher overall efficiency of the vehicle.

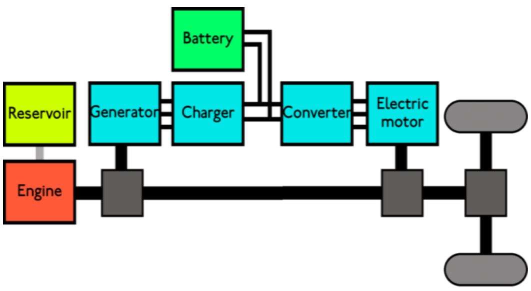

Fig 3- Power-split (Series-Parallel Hybrid) Block Diagram

B. Types by degree of hybridization

- **Full Hybrid:** Sometimes also called strong hybrid, is a vehicle that can run just on the engine, just as batteries; or combination of both. A large, high-capacity battery is needed for battery-only operation. These vehicles have a split power path that allows more flexibility in the drivetrain by inter-converting mechanical and electrical power, at some complexity. To balance the forces from each portion, the vehicles use a differential style linkage between the engine and motor connected to the head end of transmission.
- **Mild Hybrid:** It's a vehicle that cannot be driven solely on its electric motor, because the electric motor does not have enough power to propel the vehicle on its own. Mild hybrids are essentially conventional vehicles with some degree of hybrid hardware, but with limited hybrid feature utilization. Typically, they are a parallel system with start-stop only or possibly in combination with modest level of engine assist or regenerative braking features. Unlike full hybrids, mild hybrids cannot provide ICE –OFF all-electric (EV) propulsion. Mild hybrids are sometimes called Power assist hybrids' as they use engine for the primary power, with torque-boosting electric motor also connected to a largely conventional power train. The electric motor, mounted between the engine and transmission is essentially a very large starter motor, which operates not only when the engine needs to be turned over, but also when the driver "steps on the gas" and requires extra power.

C. Plug-in hybrids

A plug-in hybrid electric vehicle (PHEV), also known as a plug-in hybrid, is a hybrid electric vehicle with rechargeable batteries and restored to full charge by connecting a plug to an external power source. A PHEV shares the characteristics of both a conventional hybrid electric vehicle, having electric motor and an internal combustion engine; and of an all-electric vehicle, also having a plug to connect to the electric grid. PHEVs have a much larger-all electric range as compared to conventional gasoline-electric hybrids, and also estimate the "range anxiety" associated with all-electric vehicles, because the combustion engine works as a backup when the batteries are depleted.

Plug-in hybrids greenhouse–gas emissions, during the operating in the all-electric range mode, depend on the type of power plant used to feed electrical grid when battery is charged. If batteries are charged directly from renewable sources of electrical grid, then tailpipe greenhouse gas emissions are zero when running only on battery power. Other benefits include improved national energy security, less frequent fill-ups at the filling station, the convenience of home recharging, opportunities to provide emergency backup power in home, and vehicle-to-grid (V2G) applications.

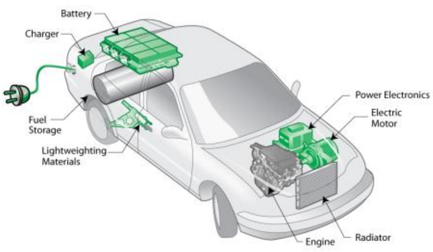

Fig 4-Circuit Diagram of Plug-in hybrid (PHEVs)

III. TECHNOLOGY

The varieties of hybrid electric designs can be differentiated by the structure of the hybrid vehicle drive train, the fuel type, and the mode of operation.

A. Engines and fuel sources

Fossil Fuels: Free-piston engines could be used to generate electricity as efficiently as, and less expensively than, fuel cells.

Gasoline: Gasoline engines are used in most hybrid designs and will remain dominant for the foreseeable future. While petroleum-derived gasoline is the primary fuel, it is possible to mix in varying levels of ethanol created from renewable energy sources.

Diesels: Diesel-electric HEVs use a diesel engine for power generation. Diesels have advantages when delivering constant power for long periods of time, suffering less wear while operating at higher efficiency.

Liquefied petroleum gas: Hyundai introduced in 2009 the Hyundai Elantra LPI Hybrid, which is the first mass production of hybrid electric vehicle to run on liquefied petroleum gas (LPG).

Hydrogen: Hydrogen can be used in cars in two ways: a source of combustible heat, or a source of electrons for an electric motor. The burning of hydrogen is not being developed in practical terms; it is the hydrogen fuel-cell electric vehicle (HFEV) which is garnering all the attention. Hydrogen fuel-cells create electricity fed into an electric motor to drive the wheels. Hydrogen is not burned, it is consumed.

Bio-fuels: Hybrid vehicles might use an internal combustion engine running on bio-fuels, such as a flexible-fuel engine running on ethanol or engines running on biodiesel.

B. Electric machines

In split path vehicles (Toyota, Ford, GM, Chrysler) there are two electrical machines, one of which functions as a motor primarily, and the other functions as a generator primarily. One of the primary requirements of these machines is that they are very efficient, as the electrical portion of the energy must be converted from the engine to the generator, through two inverters, through motor again and then to the wheels.

C. Design considerations

In some cases, manufacturers are producing HEVs that use the added energy provided by the hybrid systems to give vehi cles a power boost, rather than significantly improved fuel efficiency compared to their traditional counterparts.

D. Converion kits

One can buy a stock hybrid or convert a stock petroleum car to a hybrid electric vehicle using an aftermarket hybrid kit.

IV. ENVIRONMENTAL IMPACT

A. Fuel Consumption

Current HEVs reduce petroleum consumption under certain circumstances, compared to otherwise similar conventional v ehicles, primarily by using three mechanisms:

- Reducing wasted energy during idle/low output, generally by turning ICE off.
- Recapturing waste energy (i.e. regenerative braking).
- Reducing the size and power of the ICE, and hence inefficiencies from under utilization, by using the added power from electric motor to compensate for the loss in peak power output from the smaller ICE.

Any combination of these three primary hybrid advantages may be used in different vehicles to realize fuel usage, power, emissions, weight and cost profiles.

B. Noise

Reduced noise emissions resulting from substantial use of electric motor at idling and low speeds, leading to roadway noise reduction in comparison to gasoline or diesel powered engine vehicles, resulting in beneficial noise health effects. Reduced noise may not be beneficial for all road users, as blind people or the visually impaired consider the noise of combustion engines a helpful aid while crossing streets and feel quiet hybrids may pose an unexpected threat.

C. Pollution

Battery toxicity is a concern, although today's hybrids us NiMH batteries, not the environmentally problematic rechargeable nickel cadmium. Toyota and Honda say that they will recycle dead batteries and that disposal will pose no toxic hazards. Toyota puts a phone number on each battery, and they pay a $200 "bounty" for each battery to help ensure that it will be properly recycled.

V. ADVANTAGES

1. Energy resilience and petroleum displacement
2. Fuel efficiency
3. Operating costs
4. Range anxiety elimination
5. Smog
6. Vehicle-to-grid electricity

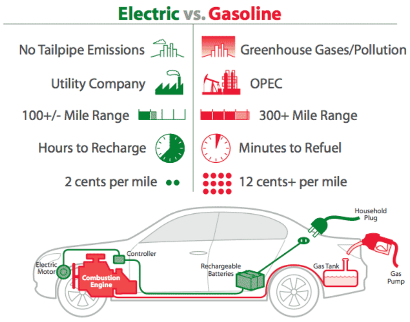

Fig 5- Comparison of Electric vs. Gasoline

VI. DISADVANTAGES

1. Cost of batteries
2. Recharging outside home garages
3. Emissions shifted to electric plants
4. Tiered rate structure for electric bills
5. Lithium availability and supply security
6. Hazard to pedestrians

VII. CONCLUSION

Many HEVs reduce idle emissions by shutting down the ICE at idle and restarting it when needed; this is known as start-stop system. A hybrid-electric produces less emissions from its ICE than a comparably sized gasoline car, since an HEVs gasoline engine is usually smaller than a comparably sized pure gasoline-burning vehicle and if not used to directly drive the car, can be geared to run at maximum efficiency, further improving fuel economy.

While initially perceived as unnecessary due to the low cost of gasoline, worldwide increases in the price of petroleum caused many automakers to release hybrids in the late 2000s; they are now perceived as a core segment of the automotive market of the future.

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