

Hybrid Electrical Vehicles: A Sustainable Technology

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ABSTRACT: HEVs have conventional cars, with an external electrical system to supplement the work of the ICE. Architecture and their level depend on, how they are connected and share load. Regenerative braking and start-stop technology make them fuel efficient in comparison to conventional cars. The CO₂ emission of HEVs is lower for all the combinations in comparison to conventional cars.

KEYWORDS: Hybrid electric vehicle (HEV), Fuel-cell electric vehicle (FEV), Internal combustion engine (ICE), Power train, Electrical machine (EM).

I. INTRODUCTION

First HEV (2) was built by Dr Ferdinand Porsche in the year 1899 and sold about 300. This Porsche 'MIXTE' (Fig.1) used BEV and a petrol engine. Petrol engine used to rotate at a constant speed to drive a dynamo for charging a battery. Battery power was used to turn a motor in order to drive front wheels of the vehicle. Subsequently it could not compete with ICEs because of price.

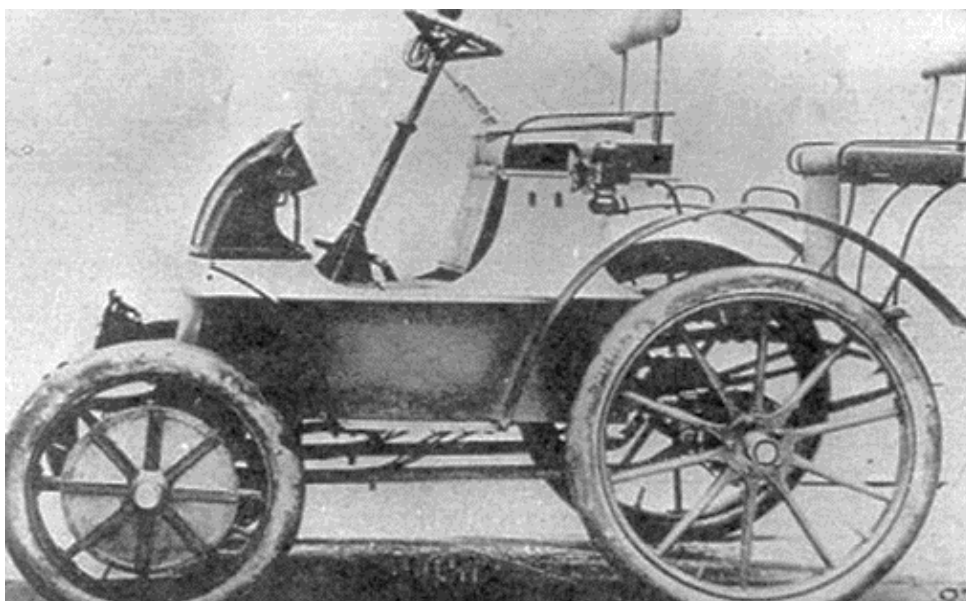


Figure 1–First HEV Lohner-Porsche [4] with Internal combustion Engine powering hub mounted electric motors.

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The use of ICEs (3) has resulted in hazards of noise, pollution and global warming. It led to development of BEV. The limitations of BEVs are short driving range, high initial cost and long charging time. That is why BEVs were limited to small car segment. Fuel cells generate electricity from hydrogen and air. They emit only water vapor. In a Fuel cell vehicle (FCVs), fuel cells are used to drive as well as charge an energy-storage device. A battery pack or a supercapacitor is used as an energy-storage device. FCVs have the potential of being highly efficient. Major issues of FCVs to be addressed are, (i) high price and the life cycle of fuel cells, (ii) onboard storage of hydrogen being highly inflammable and (iii) infrastructure for distribution and refueling of hydrogen [2]. Proto types of FCVs are yet to be proven. These are to be addressed. FCVs could be an alternative to HEVs as a long-term solution.

The limitations of ICE vehicles and BEVs has led to the development of Hybrid electric vehicles (HEVs) (3). Basically, an HEV has two systems a conventional propulsion system and an electrical machine (EM) with an energy storage system. HEVs have improved fuel economy and have also a longer driving range.

II. CHARACTERISTICS OF HEV

Following are the characteristics (1) features of Hybrid electric vehicles.

Wheels are driven by electric motor and an internal combustion engine. Energy storage is in Battery/ supercapacitor and fossil or alternative fuel. Energy source & infrastructure is Gasoline stations and electric grid charging facilities (for plug-in hybrid cars). These have low local emissions, high fuel economy, long driving range, higher cost than conventional ICE cars. These are commercially available and have issues of battery sizing, Control optimization and management of two energy sources.

A. Power train Architecture:

HEVs are propelled by two power trains (1) viz. ICE and EM. ICE provides longer range than a BEV and EM provides efficiency and pollution free mobility. HEV power train structure depends on the manner in which these two are connected.

i) Series-Parallel or combined HEVs:

It has features of both series as well as parallel hybrid systems (9). It has double connection between engine, EM and drive axle. Power split devices are incorporated in the powertrain such that wheels can be driven mechanically or electrically or both simultaneously.

This system operates as a series HEV at low power and parallel HEV at high power demands.

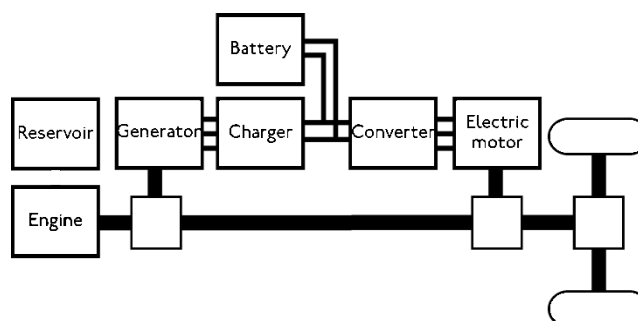


Figure 2 - Series- Parallel or Combined Hybrid System [9]

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ii Series HEVs

The ICE drives an electric generator usually a three-phase alternator plus a rectifier. It supplies power to the electric motor and also charges the battery. The ICE and the driving wheels are not coupled. So, ICE can operate in its optimum region. The controlling of series HEVs is simple due to single torque source. In addition, multi-gear transmission and clutch are not required.

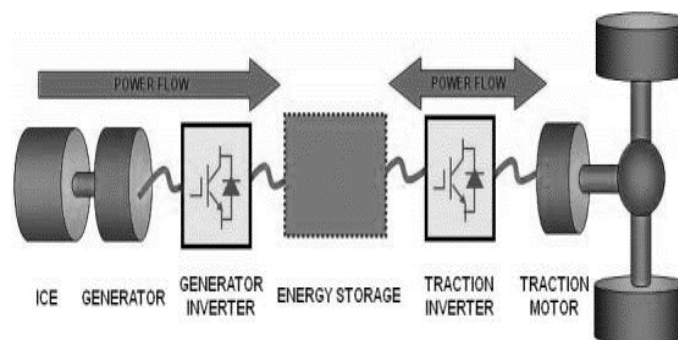


Figure 2-Series Hybrid System [9]

iii) **Parallel HEVs:** In parallel HEV system both internal combustion engine (ICE) and an electrical DC motor in parallel are connected to a mechanical transmission.

This design combines a large electric generator and a motor in one unit which are often and usually located between the combustion engine and the transmission which replaces both the conventional starter motor and the alternator. In this type of system, the battery can be charged using the regenerative braking technology as well as during cruising. Parallel hybrid system works in such a way that the electric motor drives at lower power demands as well as substantially increase the power at higher demands in addition to ICE.

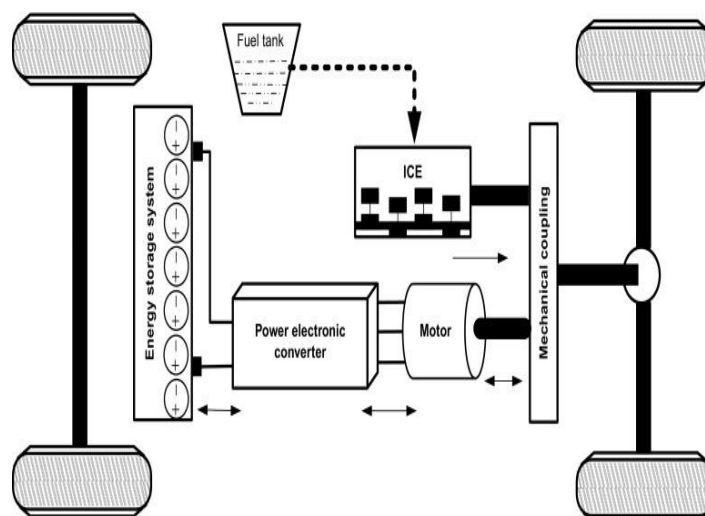


Figure 3-Parallel Hybrid System [9]

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B. HEV Architectures/ Hybrid Systems [1]

The classification of HEV architectures depends on the power sharing between the ICE and Ems in the vehicles.

- i) **Micro Hybrid:** Propulsion of Micro hybrid vehicles is ensured by the ICE. EM provides power for startup and stop& go functions. It helps in improving the fuel economy in the range of 2 to 10% for urban drive cycles.
- ii) **Mild Hybrid:** In Mild hybrid vehicles, EM does the boost function during acceleration or retardation in addition to start and stop function. It helps in fuel saving in the range of 10 to 20%.
- iii) **Full Hybrid:** Propulsion of full hybrid vehicles is ensured by electric motor and ICE is available as standby. Fuel economy is estimated in the range of 20 to 50%.
- iv) **Plug-in Hybrid:** Plugging into the electrical grid helps plug-in-hybrid vehicles to charge battery externally and use of ICE is limited to charge batteries.

C. Modelling & Energy Management Systems (1)

Modelling is a basic step in energy management. The objective of managing energy in the entire system is done by controlling the subsystems in real time and supervising the whole system.

III. MANUFACTURER'S HYBRID SYSTEMS (2)

Following are the actual hybrid systems developed by manufacturers of HEVs:

i) Hybrid Synergy Drive System (HSD)

Toyota invented and developed Hybrid Synergy Drive (HSD) system.

It allows the car to switch between the ICE and the electric motor in the most efficient and environmentally clean way. In addition, it gives best gear ratio through electronic continuously variable transmission (e-CVT) [2]. It is equipped with regenerative braking and start/ stop technique to improve fuel economy.

ii) Integrated Motor Assist System (IMA)

Honda introduced IMA (integrated motor assist), which is a parallel hybrid system. It has the EV (electric vehicle) mode for cruising at a low speed and 'start-stop' mode in which the ICE is completely shut off.

iii) Hyundai Hybrid System

Hyundai hybrid system is parallel full hybrid system and is similar to Honda IMA system. It has high driving mileage.

It has six speed automatic transmission. The engine shaft is detached when the motor alone drives the wheels.

IV. ENVIRONMENT PERFORMANCE (2, 5)

According to assessment of the data of five years HEVs had lower values of emission in comparison to conventional car. During this assessment Toyota Prius had the lowest CO₂ emissions (178 g/mile) and the conventional Toyota Highlander had the highest emission (468 g/mile).

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V.SURVEY OF HEVS & ICES GROUPS (2, 3)

This survey indicated that the criteria for conventional car buyers was quality and performance and that for hybrid car buyers was social influence and green image. Hybrid car buyers preferred maintenance by manufacturers service centers. 51% of conventional buyers were willing to switch over to HEVs.

VI.FAME INDIA (8)

The Faster Adoption and Manufacture of Hybrid and Electric Vehicles (FAME) is a Government of India scheme to promote electric mobility. It was started in 2015 to give incentives to promote HEVs.

Demand Creation, Pilot Projects, Charging Infrastructure and Technology Development are focus areas of FAME India.

VII. CONCLUSIONS

HEVs have conventional system as well as have an additional electric motor system. Architecture and their level depend on, how they are connected and share load. Regenerative braking and start-stop technology make them fuel efficient in comparison to conventional cars. The CO₂ emission of HEVs is lower for all the combinations in comparison to conventional cars. According to survey [2] the most favorable specifications of the HEVs are their fuel economy and friendly environment.

REFERENCES

- [1]C. C. Chan, Alain Bouscayrol and Keyu Chen, Electric, Hybrid, and Fuel-Cell Vehicles: Architectures and Modeling, IEEE Transactions on Vehicular Technology, Vol.59, No. 2, February 2010
- [2]B. R. Qawasmeh, A. Al-Salaymeh, A. Swaity, A. Mosleh, S. Boshmaf, Investigation of Performance Characteristics of Hybrid Cars Int. J. of Thermal & Environmental Engineering, Volume 14, No. 1 (2017) 59- 69.
- [3]Wan Ying Chua, Alvin Lee & Saalem Sadeque, Why Do People Buy Hybrid Cars? The University of Western Australia.
- [4]Aishwarya Panday, Hari Om Bansal, Hybrid electric vehicle performance analysis under various temperature conditions, The 7th International Conference on Applied Energy – ICAE2015.
- [5]E.A. Nanaki, C.J. Koroneos, Comparative economic and environmental analysis of conventional, hybrid and electric vehicles- the case study of Greece, Journal of cleaner Production 53 (2013) 261- 266.
- [6]<https://www.zedge.net/find/wallpapers/honda%20acura%20nsx>
- [7]<https://www.ucsusa.org/clean-vehicles/electric-vehicles/series-vs-parallel-drivetrains>
- [8]<https://www.sciencedirect.com/topics/engineering/parallel-hybrid-configuration>
- [9]https://en.wikipedia.org/wiki/Hybrid_vehicle_drivetrain
- [10]<https://www.indianeconomy.net/splclassroom/fame-india-scheme/>