International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 11 | Nov 2018 www.irjet.net p-ISSN: 2395-0072

Recent Trends in Hybrid Vehicles – An Overview

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Abstract - *The impact of automobiles on the environment is increasing day by day such that its becoming one of the social issue day by day. In order to regulate or prevent the future from worse Air Quality index, alternate Technologies like Electric Vehicles, Hybrid Vehicles, and fuel cells are required and introduced. With the HEV's coming in handy and is seen as a ready to use alternative solution in aspects of the infrastructural limitations. The manufacturers have been facing a high number of uncertainties with respect to market, legislation and concepts. Multiple solutions are competing, each of them having advantages in different areas. The development of efficient and cost effective hybrid technology solutions is the major aim to satisfy the customers. This paper discusses the current situation in the development of HEV, the major fundamental challenges and the innovative solutions being developed by various authors and industries to effectively address these challenge and factors involving to manufacture those at this sub-point.*

***Key Words*: Hybrid Electric Vehicles, Air Quality Index, Development of HEV, Challenges and Advantages of Hybrid.**

1. INTRODUCTION

The continuous growth of our Indian economy and with the increase of population and improvement of people's living standard, the energy which we utilize is increased and simultaneously the energy consumption is increased over the period of time. This can lead to environmental pollution[1]. The need for Development of an alternative sources of energy is to improve the efficiency of heat energy conversion, such as to save energy in effective ways in order to solve the environmental pollution and ensure energy supply[2][4]. The Alternatives to gasoline powered vehicles are increased day by day.

Some examples are pure electric vehicles, fuel-cells, hybrid vehicles. Hybrid vehicle is the one which is the new energy being backed to replace the pure form of gasoline vehicles to reduce the pollution and fuel consumptions[4].

According to the International Electro-mechanical Commission, the hybrid vehicles are the ones which run on two or more different types of power sources[6]. This article deals with the internal combustion engine and motor-driven hybrid electric vehicles. HEV is one of the key whose performance is directly related to the performance vehicles determining the efficiency. The hybrid powertrain has been designed from the structure of engine and motors to an integrated structure of engines, motors and transmissions which is named as an integrated powertrain system.

Table-1 : Comparison of different energy vehicles

New Energy	Adv	Dis-adv	App Range
Electric Vehicles	Lower cost	Short driving distance	Suitable for short-range, low-speed community
Hybrid Vehicles	Technology is mature	higher cost	To meet the daily needs
Gasoline Powered Vehicles	Less noise & pollution, good driving ability	High cost and less Technology is used.	The most widely used

2. CLASSIFICATIONS OF HYBRID VEHICLES

Hybrid powered Vehicles are classified according to the structures which are of three main forms, including **Series, Parallel** and **Hybrid.**

2.1. Series Hybrid Electric Vehicle

The Series Hybrid Electric Vehicle (SHEV) is the main driving force of the vehicle driven from the motor. There are three powertrains used in SHEV which are as following:

1. Engine
2. Generator
3. Motor

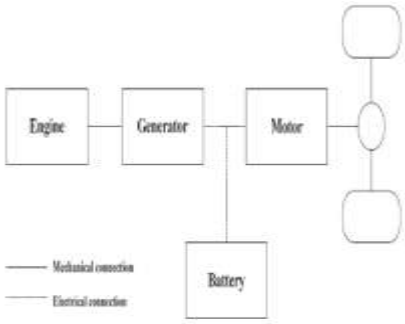


Fig-1: Series Hybrid Electric Vehicle

2.2. Parallel Hybrid Electric Vehicle

The parallel hybrid electric vehicle (PHEV) in which the engine and motor can provide the transmission or the driving torque for the vehicle simultaneously or separately. The PHEV drive system consists of two main power sources. If the load is low either one of the power source is used. If the load is more, then high power is required. In this case, both the engine and motor will be used at a time as required by the vehicle. These type of system involved complex arrangements and has some limitations.

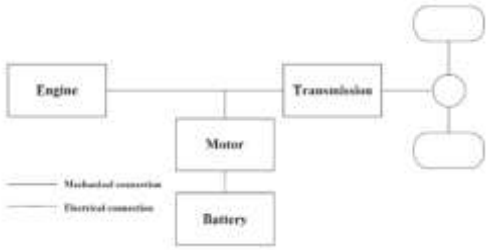


Fig-2: Parallel Hybrid Electric Vehicle

2.3. Combined Hybrid Electric Vehicle

The Combined Hybrid Electric Vehicle (CHEV) is the combined power source working in Series as well as parallel modes. CHEV involves internal combustion engine and the motor drive system which has mechanical transmission mechanism. In comparison to the parallel hybrid systems, these powertrain systems have more flexibility to relay the engine's power output and motor's varying power outputs. These systems are complex and are less cost efficient. When operating at low speed, the engine is switched off and vehicle runes only on the motor. When operating at high speed, the engine runs while the generator takes on power generation according to the working conditions.

3. HYBRID ELECTRIC VEHICLE TECHNOLOGY DEVELOPMENT TREND

In the existing technology, HEV acts as an achievement whose purpose is improving fuel economy and reducing emissions. This adds a great perspective for development of Vehicles for the future. From the current scenario, automotive emission regulations become more processed, the rapid development of electronic technology will further promote the development of hybrid vehicles.

3.1. Lower the Cost

Compared with traditional cars, HEVs can ensure the same performance and advantages, while being superior in energy saving and emission. Hybrid vehicles have similar voltage and power ratings as electric vehicles, but their battery capacity is greatly reduced, making them less costly than electric vehicles. For now, the price of HEV is about 20% higher than traditional cars. Reduce costs is one of the directions to improve the competitiveness of hybrid electric vehicle.

At Present, HEV are being worked in order for **Optimization of the Vehicles** for the wide variety of uses on different road conditions.

4. HYBRID VEHICLE TECHNOLOGIES

4.1. Hybrid vehicle functions

To maximize fuel economy and vehicle drivability, the development of hybrid vehicle functions needs the marriage of internal combustion engine and the electric machine as well as the energy storage device. The typical function of a hybrid vehicle includes the function of mild and micro-hybrid systems.

4.2. Engine is shutdown

During heavy traffic, the hybrid control system is able to shut off the engine automatically provided certain preconditions are met, e.g. the vehicle speed is lower than specified threshold; the driveline is open and the power supply system is able to support the electrical load during engine stop. The aim is to save fuel consumption and exhaust emission during engine idling. As soon as the driver wants to pull away, or the system requires the engine running in order to support certain vehicle functions, the engine will be restarted automatically.

4.3. Electric driving

If the driver wants to launch the vehicle slowly, the electric machine alone can drive the vehicle slowly. As the driver demand torque increases, the engine will be started to join the propulsion.
To strengthen the vehicle launch performance, especially for automatic transmissions, a torque smoothing algorithm is needed.

4.4. Power assist

When the driver wants to accelerate rapidly, for example overtaking on a highway, the electric machine will join in to assist the propulsion.
Due to the fast response of the electric machine the vehicle acceleration is immediate. By using this torque assist function, the transmission and fuel map can be optimized so that the best fuel economy can be achieved without compromising the vehicle drivability.

4.5. Engine driving

As the vehicle speed increases, the engine enters its high efficiency region. The electrical machine is switched off and the vehicle is driven by the internal combustion engine only. In some hybrid vehicle design, the internal combustion engine can switch to Atkinson cycle which can further increase the fuel economy by reduce the pumping loss.

4.6. Fuel cut-off

During deceleration the engine fueling is cut off. If the driver wants to accelerate again, the fueling will be resumed.

4.7. Regenerative braking

During vehicle deceleration or coasting, the electric machine can convert part of the vehicle kinetic energy into electricity which is stored in the battery for future usage. Depending on the driver's brake intention, the control system is able to adjust the power of the regenerative braking which will keep the maximum possible energy regeneration without damaging the vehicle Drivability. In the end of the regenerative braking, if the driver wants to creep the vehicle the electric machine itself will drive the vehicle slowly.

4.8. Smart battery charging

During normal vehicle driving, the battery voltage, state of charge, state of health and state of function are constantly monitored. Based on the battery information, the driver request and the engine operation, the battery charge is controlled in a manner that will keep the engine, electric machine and the battery working in the high efficiency region.

4.9. Auxiliary control

Hybridization will not only affect the powertrain and the power supply system, but also many other vehicle control systems. The biggest impact comes from engine stop/start. For example, if a vehicle has hill launch assist system, how to hold the vehicle during engine stop/start operation is a real challenge. One simple solution is to inhibit engine stop when the hill inclination is bigger than a threshold angle; however this could affect the fuel economy. Another example is the climate system control since how to maintain the driver comfort while achieving better fuel economy is a challenging task.

4.10. Fuel Economy Potential

It is not easy to improve the fuel economy of the HEV because it depends on many factors with complexity of its nature. Adding if the economic factors which as the fuel costs and the specific fuel consumption. It is very hard to either predict with much precise. In spite of these, many research activities have been carried out into various aspects of the hybrid electric vehicles.

Cuddy and Wipke (1997) have shown that the PHEV could achieve 24% better fuel economy than that of the diesel vehicles and 18% than that of the series vehicles. An et al. (1999) claims that the fuel economy can be improvised by the HEV over the Fuel on assumption rate for high performance vehicles by about 27-40% approximate value. The main advantage of the Hybrid cars is that more electrical energy is available for the passengers on board. In the study of Lukic and Emadi (2002), the propulsion system of an electric powered vehicle increase the fuel economy by 27% in the throttle actuation, steering systems.
Additionally, the potential for the hybridization of the FCV is studied by the storage works as a buffer to capture the regenerative braking energy and the fuel cell system which may benefit the compactness for a light load.

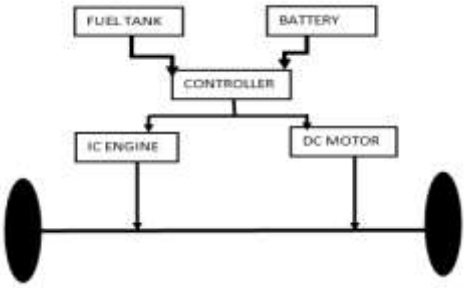
5. Current Hybrid Electric Vehicles

GM had launched two hybrid pickup truck models, Sierra and Silverado, in 2004 (Evans and Maanen, 2003). These are one of a kind of mild hybrid vehicles with electric assist of minimum usage. They used a 42V battery system installed in bell housing with a torque convertor. They have planned for a two mode power split..

In 2004, Ford contributed a SUV, Escape to the hybrid market. They validated it and licensed the power split hybrid system from Toyota (Hisada et al., 2005). The same transmission as RX400h use of structure have motor power of 65kW which is about half of the Toyota's.

Citroen launched the engine stop-start technology in the C3 1.4 It's model in 2004 using the belt driven reversible alternator technology. (Maillard et al., 2004). It has been claimed to have fuel savings of up to 15% in city driving.

Yash Lethwala[8] in his paper has described about the current progress in hybrid electric vehicle in the automobiles. He had a made the two wheeler converting it to the hybrid electric from the petrol vehicle and also he has discussed about moving from hybrid to the electric vehicle. His experimental setup is shown below:



(a)

(b)

Figure shown above

(a) The flow chart developed by the author,
(b) Experimental setup of the author.

BMW introduced the micro hybrid technology in 1-series and 5-series models with manual transmission in 2007. It included a starter motor based stop-start system, brake energy regeneration using an IAC and an AGM battery.

According to the media presentation (Green Car Congress, 2007), fuel consumption reduction of these new models is up to 27%.

6. HEV DEVELOPMENT AT AVL

At AVL, work is ongoing for the development of efficient and cost effective hybrid technology solutions for our customers. With 50 years of experience in development of powertrains based on I.C.Engines and Electric Motors, AVL has extended methods for the development of hybrid powertrains[5].
This includes computer simulation, mechanical design and integration, control development, testing solutions and benchmarking.

In the next sub-sections, main activities at AVL, especially based in the UK, are introduced. They include work on fuel economy, control, drivability and real world usage, which are crucial for HEV development process.

6.1. Fuel Economy And Emissions Simulation

6.2.

The vehicle modelling techniques can be divided into two categories according to the direction of the power flow.

- Backward
- Forward

In backward, power is calculated from the wheel to the engine, and in the forward, the power is calculated from the engine to the wheel. The backward Power flow simulation provides faster results when compared to forward results.

6.3. Drivability Assessment

Drivability is a comprehensive terminology for vehicle responsiveness, operating smoothness and driving comfort. It evaluates the overall driver feeling under various general driving conditions which include cold starts and stalls, engine speed dips, idle response, launch hesitations and performance. The following conditions are considered as drive ability problems (Wei, 2004);

• Delay Period
• Less power Delivery
• Starting Issues
• Power Variation

The vehicle can accelerate and de-accelerate with no change in the accelerator pedal position.

• Instability
• Vibration and Noise

As engine stop-start is one of the primary features of all hybrid vehicles, the engine starting performance becomes an important drivability requirement of the system as it is also coupled with the vehicle launch performance.

The physical model provides a useful CAE tool for the engine cranking performance with an electric machine, to support system design evaluation without hardware modifications. Further work is being done to extend the CAE tools to support engine starting predictions with ATs and also to vehicle models for predicting launch performances under stop-start mode.

6.4. Real-World Usage Investigation

The design requirements of the components in a HEV are quite different as compared to a conventional vehicle. As the HEV components are subjected to different driving modes and therefore different stress levels, it is important to develop a methodology which would predict targets for the components taking into account there real world usage.

As an example the engine stop-start mode is a common feature of all HEVs and is especially significant for a micro hybrid. The stop-start of the engine obviously will lead to an increase in the number of engine starts compared to traditional usage patterns which in turn leads to an increase in the stresses placed on components involved in the engine start event e.g. the starter motor. In order to determine that these components can meet this increase in the number of start cycles reliably and hence determine the trade between component cost and fuel economy savings it is necessary to refine the durability testing that the systems are subject to. It is vital to first understand the number of start cycles that the stop-start strategy will impose on the vehicle in real world usage to set these new durability targets.

This methodology provides a useful tool which involves the calculation of durability. Work is going on to extend the developed tools to support fuel savings predictions and also for different vehicle applications.

6.5. Health Effects

Emissions have been causing a number of health effects and also on the environmental conditions.
Respiratory problems have been an alarming risk and has lodged highest complaints due to the emissions. These also has an increase on a person' s risk of cancer-related death. These are just a few examples of the problems which can arise from the pollution from vehicles, particularly CO_2 emissions. Asthma is also one of the health related problems which has been significantly increased since last 5 years.

Another form of vehicle related effect is acoustic pollution. Loss of hearing, high blood pressure, sleep deprivation, productivity loss and a general reduction in the quality of life can all develop from the noise of traffic. The greatest and most condemning effects do stem from larger vehicles; including buses and trucks. There has been researches into the inclusion of HEV buses, primarily within the US, which has helped to reduce the problem caused from conventional buses.

From this it can be observed that much of the sickness is caused by the vehicle pollution. A number of regulations has been put by the government on the emission norms but there is still an alarming rise in the percentage of pollution from vehicles. Strict measures can lead to more efficient and environmental friendly vehicles.

7. CONCLUSION

In conclusion it can be seen that the grow thin market potential of HEV s is strongly influenced by the movements of legislation. Therefore, benefits and stringent emission legislation is common in areas where HEV shave been successful. The US and the European markets are two important automotive markets which have been analyzed in order to demonstrate the current success of HEV's.
The Indian market is one which is showing its growth in the automotive industry has been developing major constraints to improve hybridization and control the emission as low as possible. The hybrid vehicles can deliver a sub-descriptive high performance and efficiency. In short hybrid and Electric Vehicles are the future which could help us reduce the consumption of fuel and also follow specified emission norms.

REFERENCES

1. Zhang Chun, Zeng Qing-xi and Zhu Hao, "Review on Development of Hybrid Electric Vehicles", Mechanical Engineering & Automation, No. 2 Apr.2016, pp.222-224.

2. Dai Mengping and Ji Yongqiu, "New Power for Vehicle—HEV System Summary," Agricultal Equipment & Vehicle Engineering. N0.9 2006(Totally 182), pp.7-10.

3. Ernest Henry Wakefield, "History of the Electric Automo-bile Hybrid Electric Vehicles". Warrendale: Society of Automotive Engineers, inc.1998.

4. Matthew R. Cuddy and Keith B. Wipke. "Analysis of the Fuel Economy Benefit of Drivetrain Hybridization". SAE paper 970289, 1997.

5. Graham Johnson. "Electric'99& hybrid vehicle technology international". New Malden: UK & International Press, 1999.

6. Hao Zhi-yong, Yue Dong-peng and Li Jian-guo. "Research Situation and Development Prospect on HEV". Railway Locomotive & Car, Vol.23 Suppl.1 Nov.2003, pp.205-209.

7. Huang Xian-guang, Lin Yi, He Hong-wen and Wei Yue-yuan. "Situation and Development Trend of Hybrid Cars Powered Electromechanical Coupling System", Shanghai Automotive, 2006. 07, pp.2-5.

8. Yash Lethwala, "Development Of Automotive Hybrid Electric System", Lamsys-18, ISRO, 2018.