STUDY ON TRENDS IN HYBRID ELECTRIC VEHICLES

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Abstract. Environmental pollution is worsening due to an increase in per capita energy consumption. It is imperative to reduce the use of conventional fuel-powered engines by utilizing new alternative energy sources. In addition to the short production period, there are many problems with electric vehicles, such as inadequate charging facilities. In this regard, hybrid electric vehicles have become particularly important in recent years. An overview of hybrid vehicles, their classification, research status, and future development trends is presented in this paper. Hybrid electric vehicles can be better understood by the public, which is theoretically significant.

Keywords:component;newenergy;hybridvehicle;classification;developmenttrend.

1. Introduction

Due to the continuous growth of the world economy and population and the improvement of people's living standards, the per capita energy consumption will increase rapidly, causing environmental pollution to worsen.Environmental pollution can be solved or alleviated by developing alternative energy sources, improving heat energy conversion efficiency, and saving energy. Pure electric vehicles, fuel-cell vehicles, hybrid vehicles, and other alternatives to fuel-powered vehicles are also on the rise. Three major new energy vehicles are compared in Table 1. Hybrid electric vehicles are among the new energy vehicles and are by far the most practical. An electric vehicle that is hybrid refers to a vehicle drive system that is powered by at least one type of power source, according to the International Electromechanical Commission's proposal on electric vehicles. [1]. Neither internal combustion engines nor motor-driven hybrid electric vehicles are discussed in this article. In hybrid vehicles, hybrid electric vehicles are the key system, and their performance is directly related to their performance. The hybrid powertrain has evolved from a discrete structure of engines and motors to an integrated structure of engines, motors, and transmissions, namely an integrated powertrain system, after more than a decade of development.

TABLE1. Comparison of three major new energy vehicles

New Energy Vehicles	Advantage	Disadvantage	ApplicationRange
Electric Vehicles	Lower cost	Short driving distance	Suitable for short-range, low-speed community
Hybrid Vehicles	Technology is mature	Higher cost	To mee tthe daily needs of users
Fuel Powered Vehicles	Small noise, zero pollution, good Driving ability and great mobility	Technology is not yet Mature and costly	The most widely used

2. Classification of Hybrid Vehicle

Classification: HEV can historically be categorized into three types: **HEV sequence, HEV parallel, and HEV combination.**

Series Hybrid

As shown in Fig. 1. The electric motor supplies the traction power [3], while the internal combustion engine generates electric power to drive the electric motor [2]. Batteries are used to store excess power. In the maximum efficiency region, the Internal Combustion Engine is decoupled from the driven wheels and can operate mostly at maximum efficiency. The major shortcomings of series hybrid drive train configurations are the high power installed in each component and the need for a generator. A car's wheels are driven by the energy that is converted twice from an internal combustion engine. In this way, the parallel system is more expensive than the serial system.

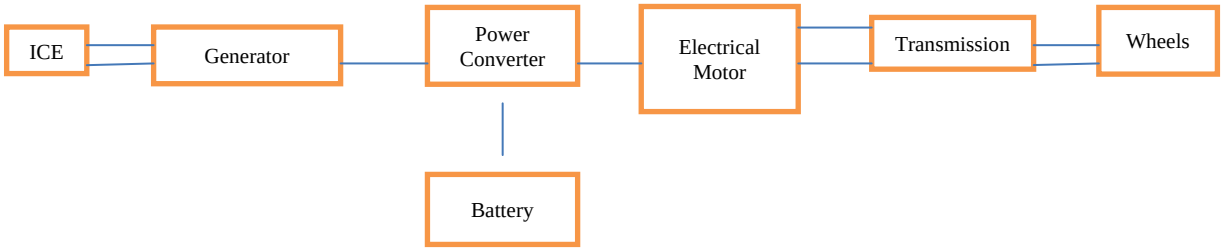

Fig.1:Series Hybrid Structure

Parallel Hybrid

As shown in Fig. 2, [3] there is a direct mechanical connection between the hybrid power unit and the wheels. Moreover, this layout has an electric traction motor that drives the wheels and can recuperate braking energy, so as to charge the batteries (regenerative braking) or assist the Internal Combustion Engine during acceleration. A mechanical device connects the Internal Combustion Engine and electric motor. As a result, the electrical machine can be designed with a reduced capability, i.e. cost and volume. Depending on the mechanical combination between the Internal Combustion Engine and the electrical motor, there are several configurations. Torque-couplings can have a single shaft or two shaft configuration, speed-couplings with planetary gear units, or a combination of both.

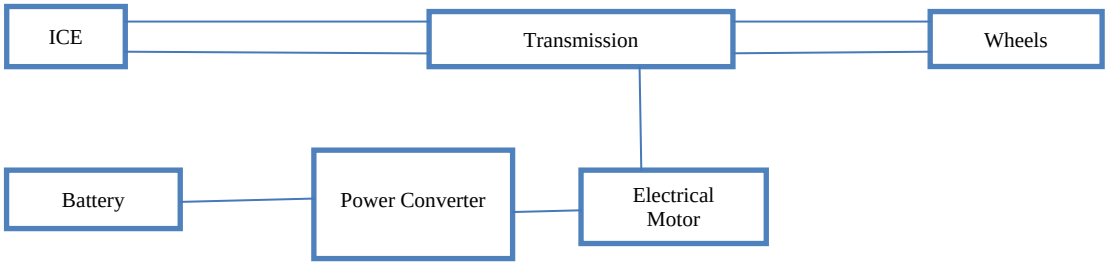

Fig.2:Parallel Hybrid Structure

Combined Hybrid Vehicle

As shown in Fig. 3, [3] the serieslayout and the parallel layout are merged together in order tohave both advantages. In particular the ICE is able to supply the electrical motor or charge the battery thanks to a generator.

Combined Hybrid Electric Vehicle (CHEV) directly combines the series and parallel, which can work in series mode or in parallel mode. Hybrid electric hybrid system is characterized by the internal combustion engine system and the motor drive system with mechanical transmission mechanism, the two sets of agencies or through the gear train or planetary gear structure connected to regulate the

relationship between the internal combustion engine and the motor speed. Compared with parallel hybrid systems, hybrid powertrain systems have more flexibility to adjust the engine's power output and motor operation based on operating conditions. This connection system is complex and costly. When the vehicle starts or runs at a low speed, the engine is shut down and only the motor is used to provide the power output. When the car is running at high speed, the engine runs while the generator takes on power generation or speed regulation according to the actual working conditions. When the vehicle is braked, the system is also capable of converting mechanical energy into electrical energy stored in a battery pack.

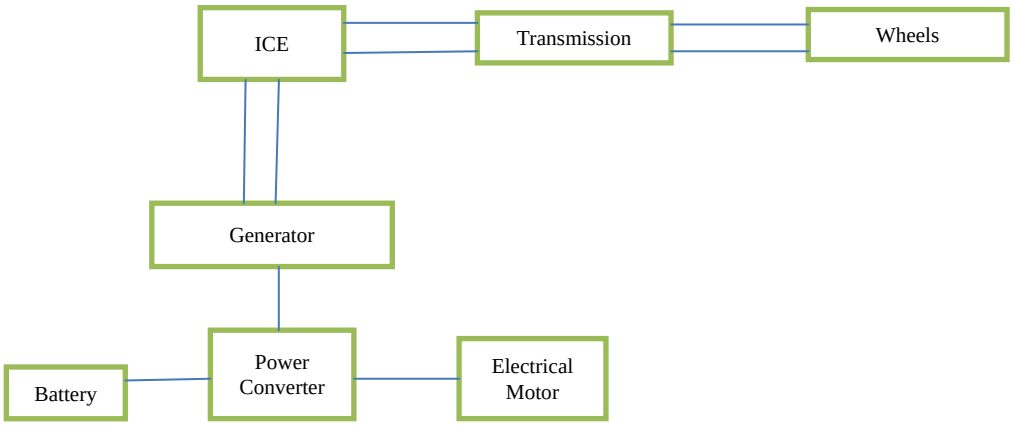

Fig.3: Combined Hybrid Structure

Other classification Methods

According to the hybrid system, the output power of the motor in the system output power accounted for the proportion, which is often said that the different degrees of mixing, hybrid systems can also be divided into five categories, including micro-hybrid systems, light hybrid System, hybrid system, complete hybrid system, external power outlet charging hybrid vehicle.

3. Status of HEV in India

The India automobile market by vehicle type is separated into two-wheeler, commercial passenger cars, and others. The most preferential vehicles are passenger cars and two wheelers, and this segment will dominate in the electric vehicle market. Indian passenger cars division is predicted to seize three fourths of the electric vehicles market share by 2026.

The future of electric vehicle transportation is developing with changes in consumer preferences and environmental sustainability to reshape the automotive industry. An automobile is a connected device with increased intelligence for driving functions. Changing consumer preferences and technological disruptions are transforming the facet of mobility, urging automakers to rethink plan and strategize.

Implementation of Emission Standards In India: In the World Bank environmental quality survey among 172 countries, India is at155, and in air pollution it is last. The Auto Fuel & Vision Policy 2025 of India, published in 2014, proposed rolling out nationwide BS-IV, BS-V, and BS-VI (based on Euro 4, Euro 5, and Euro 6) over a staged timeline by 2017, 2020, and 2024 respectively. However, as air pollution worsens, India has been pondering between adopting BS-VI and directly transitioning to BS-VI up gradation. in November 2015 The Indian government published a notification for execution of BS-V and BS-VI by 2019 and 2021 . It is predicted that the proposed upgrades can lessen PM and NOx vehicular emissions to the range of 40 percent – 80 percent on the set timeline. Sector specialists are requesting direct transitioning to BS-VI as performance of Euro 5 for NOx control in diesel vehicles has been substandard, and Euro 6 rise above this as a better performing standard.

INDIA ELECTRIC VEHICLE MARKET: DRIVERS In India, despite numerous challenges and difficulties, electric vehicles are gradually increasing due to 1. Electric vehicle

incentives under FAME India launched by central government to achieve a production of ~ 7 Million EV's by 2020 and NEMMP 2020 target 2. Low maintenance operations costs for electric vehicles 3. Rising crude oil cost as 80% of crude oil requirement is imported Although, in India's EV market is at a very nascent stage and , currently the challenges seem to outweigh the opportunities in India but the right steps from government by support dynamics for EVs in India at various levels is anticipated to transform it as opportunities are in large numbers in future.

4. The Status of Abroad HEV Research

Currently, the United States, Japan and Germany are leaders in hybrid vehicle research. In the United States, for example, many innovative electric car manufacturers such as Tesla and others received more than double their interest-free loans from the government more than $ 10.4 billion six years ago for hybrid and pure electric vehicles. As a result, the current US hybrid market has a 3.5% market share (taking into account the large U.S. vehicle base). Japan also made tremendous achievements in the research and development of hybrid vehicles. The world-famous Toyota Prius, the world's most technologically mature and most acclaimed hybrid electric vehicle with a total sales volume of 10 million vehicles, currently holds 11% of Japan's hybrid vehicle [3]- [5]. Representative of the advanced foreign hybrid vehicles: General Motors hybrid, Toyota Prius, Lexus LS 600hL and so on.

5. The Key Technology of Hybrid Electric Vehicle

With the gradual development of HEV, new requirements are put forward for the development of hybrid technology. The key technologies include the following aspects:

Advanced internal combustion engine technology

Like conventional ICE vehicles, HEVs also require advanced internal combustion engine technology to improve fuel economy and reduce exhaust emissions.

Battery storage technology

Based on the current battery storage technology, how to improve the storage capacity of the battery pack is still the key to the development of hybrid electric vehicles and even electric vehicles. In a sense, the cost, size, convenience and service life of the battery determine the marketization process of the hybrid vehicle. Increasing the storage capacity of the battery pack can effectively reduce vehicle fuel consumption, reduce exhaust emissions, increase mileage and further enhance the advantages of the hybrid vehicle.

Hybrid control unit technology

The purpose of hybrid vehicle energy management is to design a reasonable control algorithm to determine the amount of power generated and the energy distribution between different power sources. The goals are to achieve the best possible fuel economy and minimize exhaust emissions, extend the battery SOH value, improve the stability of vehicle dynamics and so on. At present, there are two main control strategies for plug-in hybrid vehicles: rules-based energy management strategy and intelligent algorithm-based energy management strategy. Among them, the energy management strategies based on intelligent algorithms include energy management strategies such as instantaneous optimized energy management strategy, global optimal energy management strategy, neural network based energy management strategy and genetic algorithm based energy management strategy.

Simulation Technology

There are many non-linear relationships in HEV components and the interaction between components is complex. There are usually three ways to judge the strengths and weaknesses of different design scenarios and to test the actual effects of various control strategies: building a prototype of a car, performing a large number of experiments and using simulation techniques, the first two being time-consuming, massive amounts of manpower, material and financial resources. The use of simulation technology is not only flexible, easy to adjust the design, optimize the design parameters, but also reduces research costs and shorten the development cycle. Therefore, simulation technology is one of the important technologies in hybrid vehicle research and development.

6. Hybrid Electric Vehicle Technology Development Trend

Based on the existing technology, HEV achieves the purpose of improving fuel economy and reducing emissions, and thus has great prospects for development. From the

current development point of view, automotive emission regulations become more stringent, while the rapid development of electronic technology will further promote the development of hybrid vehicles. The future development of hybrid electric vehicle technology in India should focus on the following aspects.

Develop Combined Hybrid Vehicles

Series and parallel HEV have their own advantages and disadvantages, hybrid approach is a relatively perfect hybrid system, which can better combine the advantages of fuel-efficient vehicles and electric vehicles, (motor efficiency, noise Low pollution-free, the engine is always working at the highest efficiency, with good fuel economy, acceleration and stability), can effectively make up for the lack of series and parallel hybrid vehicles. Therefore, the future development of a new hybrid system should be based on the advantages of serial and parallel structure, so that a structure to be reflected in many companies and research institutes now gradually combined hybrid vehicles as a development focus [6].

Optimization of Control Strategy

Hybrid vehicles using the control methods are baseline control, intelligent control, real-time optimal control, global control. At present, the most used control strategy of HEV is rule-based logic threshold strategy. The logic threshold value strategy is concise, the code is efficient and has good robustness. However, the fuel consumption and emissions cannot be considered synthetically. Therefore, the optimization of the control strategy is a developing trend at present. At present, except for the rule-based logic threshold policy, other control strategies (especially parallel hybrid vehicles) are not yet mature. Due to the complexity of the parallel hybrid vehicle operating mode than the tandem type, the control strategy is not only to achieve the best fuel economy of the vehicle, but also to adapt to various operating conditions of the vehicle, taking into account engine emissions, battery life, driving performance, Various parts reliability and cost, and many other requirements, and for the various components of the vehicle comprehensive control. The study of control strategies that take into consideration all the above requirements is a key and difficult task in the future.

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 [7].

Development of Independent Simulation Platform

At present, there are two common methods for modeling and controlling hybrid vehicles, one is through commercial vehicle simulation software such as ADVISOR and CRUISE and the other is multi-software platform joint modeling and control simulation such as ADVISOR Co-simulation with MATLAB. However, at present, and the last updated version of ADVISOR is 2016 the model is old and the CRUISE model cannot be flexibly changed. Therefore, it has been unable to meet the rapid development of India's hybrid vehicle development test research needs. Multi-software platform for joint modeling and control simulation also exists multi-platform compatibility is not strong, poor readability, easy to operate, poor data transfer problems. Therefore, it is necessary to develop commercial vehicle simulation software that is in line with India's national conditions.

7. Conclusion and Future Scope

The use of electric vehicles is growing rapidly around the world as a sustainable form of transportation. In addition, the Indian government has begun to accelerate the adoption of EVs. However, many hurdles have to be overcome before EVs can be adopted widely and easily in India. As a nascent player in the EV transportation market, the most important barriers identified are state government incentives and consumer characteristics. Consumers are enthusiastic about reducing pollution, but the various costs (purchasing cost, minimum operating cost, vehicle cost, payback period, operating cost, maintenance cost and electricity cost, resale) are

high. Thus, in the Indian market, a vehicle that is cost-effective is necessary. The Center for Future Mobility organized industry meetings in Delhi and Chennai that highlighted high acquisition costs as the biggest barrier to EV adoption. The charging infrastructure, the electric vehicle performance safety concerns and the new user anxiety affect EV adoption strongly. Thus, the researcher believes penetration pricing is more suitable for the Indian automobile industry, which is dominated by middle-class consumers. Since a lot of national fuel can be conserved by using these electric vehicles along with reducing emissions, Indian automobile policymakers must take advantage of growth in this sector.

References

[1] Hybrid Electric Vehicles: An Overview of current technology and its application in developing and transitional countries. Printed, United Nations Environment Programme, Nairobi, Kenya, September 2009.

[2] M. Barcaro, N. Bianchi, F. Magnussen. PM Motors for Hybrid Electric Vehicles. The Open Fuels & Energy Science Journal, Vol. 2, pp. 135-141, June 2009

[3] M. Ehsani, Y. Gao, S. Gay, A. Emadi. Modern Electric,HybridElectric,andFuelCellVehilces,CRCPress:USA, 2005.

[4] M. Barcaro, N. Bianchi, F. Magnussen. PM Motors forHybridElectricVehicles.TheOpenFuels &EnergyScienceJournal, Vol. 2,pp. 135-141,June2009.

[5] Yaegashi.InChallengeofAchievingSustainableMobilitythroughHybridization,ResearchandDevelopment of Hybrid Vehicles in Japan and SwedenSeminarim,Göteborg, Sweden, 2006.

[6] Zs.Preitl,P.Bauer,J.Bokor.FuelConsumptionoptimizationforHybridSolarVehicle,Page:11-18.International Workshop on Hybrid and Solar Vehicles.UniversityofSalerno,Italy.November5-6,2006.

[7] C. C. Chan, A. Bouscayrol ,and K. Chen, “Electric, hybrid, and fuel-cell vehicles architecture and modeling,” IEEE Transactionson Vehicular Technology, vol. 59, no. 2, Article ID 5276874, pp. 589–598, 2010.