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An Overview of the Emerging Automotive Hybrid Technology

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Abstract: ***Environmental degradation is getting worse as per capita energy use rises. It is crucial to reduce the use of traditional fuel-powered engines while utilising innovative alternative energy sources. Pure electric vehicles cannot be mass produced due to the short timeframe and there are several issues, such as inadequate charging infrastructure. As a result, there is a particular time when the development of hybrid electric vehicles is crucial. This essay introduces the classification of hybrid vehicles, their current state of research, and their likely future development tendencies. It helps the general public understand hybrid electric vehicles, which is important theoretically.***
Keywords: hybrid vehicle; new energy; classification; development trend.

I. INTRODUCTION

The global economy, population, and living standards are all continuing to grow, which means that per capita energy consumption will rise quickly, creating more major environmental problems. Environmental deterioration creating new alternative energy sources and increasing heat energy efficiency Conversion and energy conservation are seen as efficient solutions to address or reduce environmental pollutants and make sure power supply. Vehicles that run on fuel have more and more competition from pure electric vehicles, fuel-cell cars, hybrid cars, and similar vehicles. One of the new energy vehicles that has seen commercial success is the electric vehicle, which is also by far the most practical. A hybrid electric vehicle is one that is powered by two or more different types of power sources, at least one of which is able to produce power[1], according to the suggestion of the International Electromechanical Commission Electric Vehicle Technical Committee. Only internal combustion engines and motor-driven hybrid electric cars are covered in this article. The main hybrid system is hybrid electric vehicles, and the efficiency of these vehicles directly affects the efficiency of hybrid vehicles. The hybrid powertrain has undergone more than a decade of evolution, changing from a discrete structure of engines and motors to an integrated structure of engines, motors, and transmissions, or an integrated power train system.

II. STUDY OF HYBRID VEHICLES

According to its construction, hybrid power systems can be classified as series, parallel, or hybrid [2].

A. Series Hybrid Electric Vehicle

The primary characteristic of a vehicle that derives all of its power from a motor is a series hybrid electric vehicle, or SHEV. The engine is not directly involved in the SHEV drive system, it is combined with the generator merely as a power supply system. The SHEV drive system is formed of the three power trains: engine, generator, and drive motor as shown in fig 1.

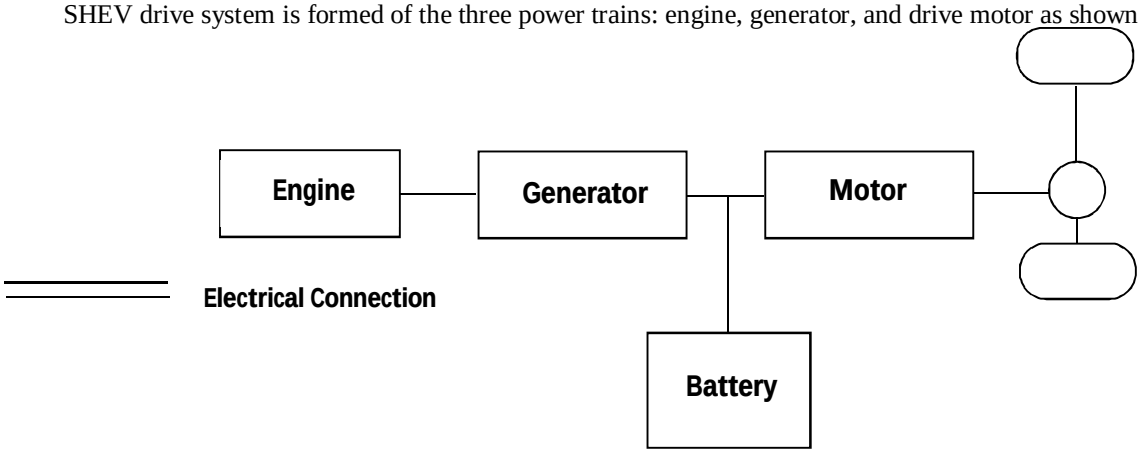

FIGURE 1. Series hybrid system structure

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B. Parallel Hybrid Vehicle

The ability of the engine and motor to produce the vehicle's driving force either simultaneously or independently is the primary characteristic of a parallel hybrid electric vehicle (PHEV). The PHEV drive system consists of two primary power sources: the engine or the motor is used alone when the load is low, and the engine and the motor can be used concurrently when a considerable amount of power is required. The PHEV drive system is not as straightforward as the tandem type since the two power sources are superposed on top of one another in the form of mechanical energy as shown in the figure 2, which necessitates corresponding mechanical transmission [3].

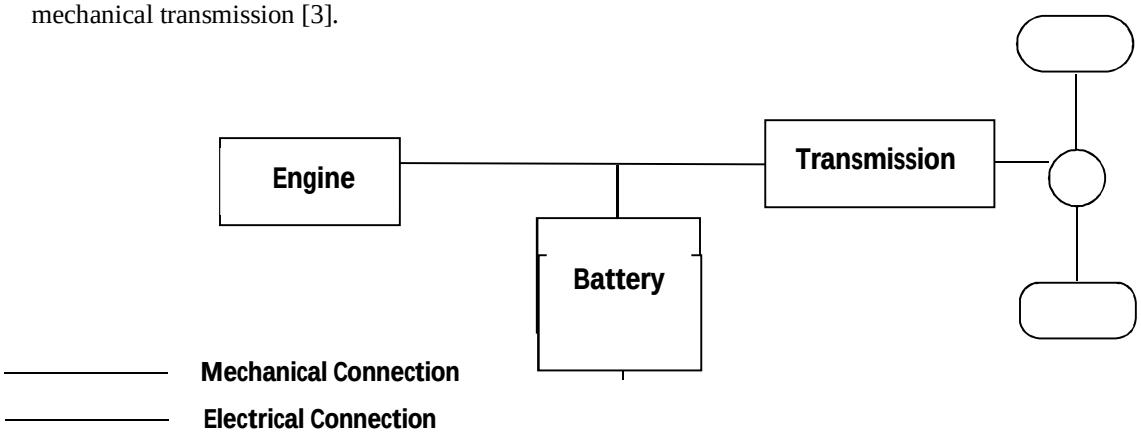

FIGURE 2. Parallel hybrid system structure

C. Combined Hybrid Vehicle

The series and parallel are directly combined in combined hybrid electric vehicles (CHEV), which can operate in either series mode or parallel mode. Internal combustion engine and motor drive systems with mechanical transmission mechanisms are the distinguishing features of a hybrid electric hybrid system as shown in the figure 3. 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 In comparison to parallel hybrid systems, hybrid power train systems are more adaptable to changing operating conditions and can change the power output of the engine and the functioning of the motor. The connection system is expensive and complicated. The connection system is expensive and complicated. The engine is turned off and just the motor is used to generate power when the car is starting or moving at a low pace. When the car is moving at a high speed, the engine continues to operate while the generator controls the speed or generates power depending on the circumstances. The technology can also transform mechanical energy into electrical energy that is stored in a battery pack when the brakes are applied to the car.

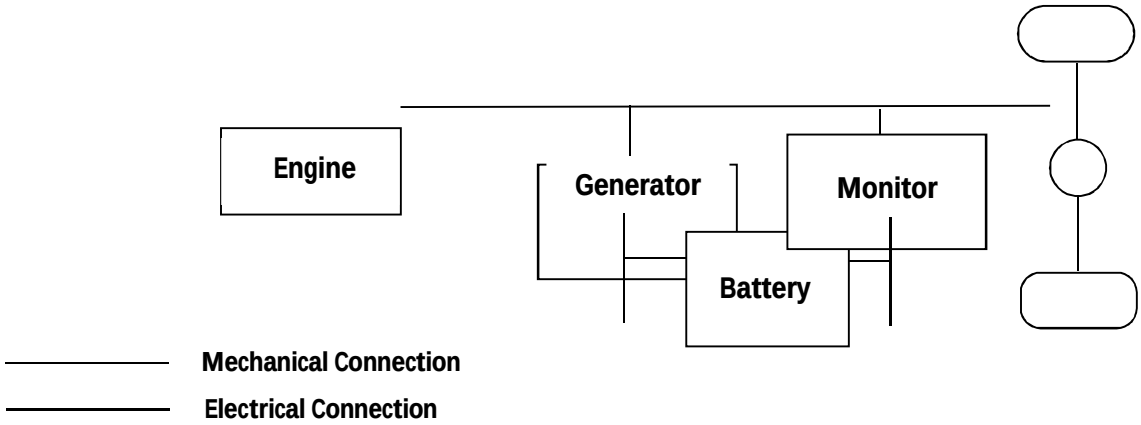

FIGURE 3. Combined hybrid system structure

D. Other Types

Hybrid systems can also be divided into five categories, including micro-hybrid systems, light hybrid systems, hybrid systems, complete hybrid systems, and external power outlet charging hybrid vehicles. According to the hybrid system, the output power of the motor in the system output power accounted for the proportion.

III. HEV RESEARCH STATUS

A. How domestic HEV research is doing

The development of new energy systems is currently being pursued actively by at least 8 self-owned automobile firms in China, including SAIC, FAW, Dongfeng, Changan, Chery, Geely, BYD, and the Great Wall. The FAW Group hybrid sedan, the Shanghai GM Buick hybrid sedan, the Shanghai Volkswagen Passat fuel cell vehicle, the Beijing Foton fuel cell hybrid city bus, the FAW hybrid city bus, the Chongqing Changan hybrid bus, and the Dongfeng hybrid electric city bus are among them. The pure electric vehicles and electric buses created by Tsinghua University and Tianjin Qingyuan Electric Vehicle Co., Ltd. have passed the type certification test of the national quality inspection centre. Dongfeng Electric Vehicle Co., Ltd. was established with funding from Dongfeng Motor (600006), Wuhan University of Technology, and other sources to do hybrid vehicle research and development.

B. The Current State of Foreign HEV Research

Currently, Germany, Japan, and the United States are at the forefront of hybrid car research. For instance, numerous cutting-edge electric car producers in the US, like Tesla and others, obtained more than double the amount of interest-free loans ($10.4 billion) from the government six years ago for hybrid and all-electric vehicles. The present US hybrid market has a market share of 3.5% as a result (taking into account the large U.S. vehicle base). Japan achieved outstanding progress in the study and creation of hybrid automobiles. With 10 million units sold worldwide, the Toyota Prius, the most well-known and technologically advanced hybrid electric vehicle, presently controls 11% of the hybrid vehicle market in Japan [3] - [5]. Advanced foreign hybrid cars that are examples include the General Motors hybrid, Toyota Prius, Lexus LS 600hL, and others.

IV. THE ESSENTIAL HYBRID ELECTRIC VEHICLE TECHNOLOGY

New needs for the development of hybrid technology are being put forth with the progressive development of HEV. The following elements are among the important technologies:

A. High-Tech Internal Combustion Engines

To increase fuel efficiency and lower exhaust emissions, HEVs need modern internal combustion engine technology much like conventional ICE vehicles do.

B. Modern Battery Storage

Based on existing battery storage technology, the key to the development of hybrid electric vehicles and even electric vehicles is how to increase the battery pack's storage capacity. In a way, the hybrid vehicle's marketization process is determined by the price, size, convenience, and service life of the battery. Increasing the battery pack's storage capacity can significantly decrease fuel consumption, lower exhaust emissions, improve mileage, and advance the benefits of hybrid vehicles.

C. Technology for Hybrid Control Units

The goal of hybrid vehicle energy management is to provide a logical control algorithm to choose how much power is generated and how it is distributed among various power sources. The objectives are to maximise fuel efficiency, reduce exhaust emissions, increase battery SOH value, enhance vehicle dynamics stability, and so on. There are now two primary control systems for plug-in hybrid cars: clever algorithm-based energy management and rules-based energy management. There are several energy management techniques based on intelligent algorithms, including instantaneous optimised energy management, global optimal energy management, neural network-based energy management, and genetic algorithm-based energy management.

D. Technology in Simulation

HEV components exhibit a wide variety of non-linear correlations, and complex interactions exist between them. Building a working prototype of a car, conducting numerous experiments, and using simulation techniques are the typical three methods for evaluating the benefits and drawbacks of various design scenarios and testing the effectiveness of various control strategies.

The first two methods require extensive amounts of time, manpower, materials, and financial resources. The use of simulation technology not only makes designs flexible, simple to modify, and the design parameters easier to optimise, but also lowers research expenses and speeds up the development process. As a result, one of the key technologies in the study and development of hybrid vehicles is simulation technology.

V. TREND IN TECHNOLOGY DEVELOPMENT FOR HYBRID ELECTRIC VEHICLES

HEV has excellent development potential because it accomplishes its goals of increasing fuel efficiency and lowering emissions based on the available technology. From the perspective of contemporary development, automotive emission standards are becoming stricter, and the quick advancement of electronic technology will further encourage the creation of hybrid vehicles. The following aspects should be the main focus of future hybrid electric vehicle technology development in China.

A. Develop Combined Hybrid Automobiles

Hybrid method is a reasonably ideal hybrid system that can better integrate the benefits of fuel-efficient automobiles and electric vehicles (motor efficiency, noise reduction). Series and parallel HEV have their own advantages and limitations. Low pollution, constant engine efficiency, good fuel economy, quick acceleration, and stable driving can effectively compensate for the absence of series and parallel hybrid vehicles. Therefore, the advantages of a serial and parallel structure should serve as the foundation for developing a new hybrid system in the future. As a result, many businesses and research institutions are gradually combining hybrid cars as a development priority [6].

B. Enhancing the Control Strategy

Baseline control, intelligent control, real-time optimal control, and global control are all control systems used in hybrid vehicles. Rule-based logic threshold technique is now the most popular HEV control strategy. The code is effective and efficient, and the logic threshold value technique has strong robustness. However, it is impossible to view emissions and fuel usage as synthetic. Therefore, a current trend that is developing is the optimization of the control approach. Except for the rule-based logic threshold policy, other control strategies—particularly those involving parallel hybrid vehicles—are still in their early stages of development. The control strategy is not only to optimise the vehicle's fuel efficiency but also to adapt to various driving conditions, taking into account engine emissions, battery life, driving performance, various parts reliability and cost, and many other requirements, as well as for comprehensive control of the vehicle's various components. This is because driving a parallel hybrid car is more complicated than one that is tandem in nature. It will be important and difficult to conduct future research on control systems that take into account all of the aforementioned needs.

C. Reduce the Cost

HEVs can provide the same performance and benefits as conventional vehicles while outperforming them in terms of energy conservation and emissions. The voltage and power ratings of hybrid vehicles are comparable to those of electric vehicles, but because their battery capacity is significantly less, they are less expensive than electric vehicles. Currently, HEVs cost roughly 20% more than conventional vehicles. One way to increase the competitiveness of hybrid electric vehicles is to reduce expenses [7].

D. Creation of a Standalone Simulation Platform

A commercial vehicle simulation programme like ADVISOR or CRUISE or a combined modelling and control simulation using multiple software platforms, such ADVISOR Co-simulation with MATLAB, are currently the two most popular ways to model and control hybrid vehicles. However, as of right now, China lacks a national commercial vehicle simulation model, ADVISOR hasn't been updated since 2004, the model is antiquated, and the CRUISE model cannot be easily modified. As a result, it has been unable to keep up with China's rapidly expanding needs for hybrid car development test research. There is also a multi-software platform for cooperative modelling and control simulation. Lackluster cross-platform compatibility, poor readability, ease of use, and data transfer issues. Therefore, it is essential to create commercial vehicle simulation software that takes China's national circumstances into account.

VI. CONCLUSION

Internal-combustion automobiles are unquestionably less eco-friendly than hybrid autos. Batteries are being designed with a long life in mind. Battery recycling will become economically feasible as hybrid vehicles become more common. Future prospects for hybrid vehicles appear more promising thanks to research into alternative energy sources including fuel cells and renewable fuels.

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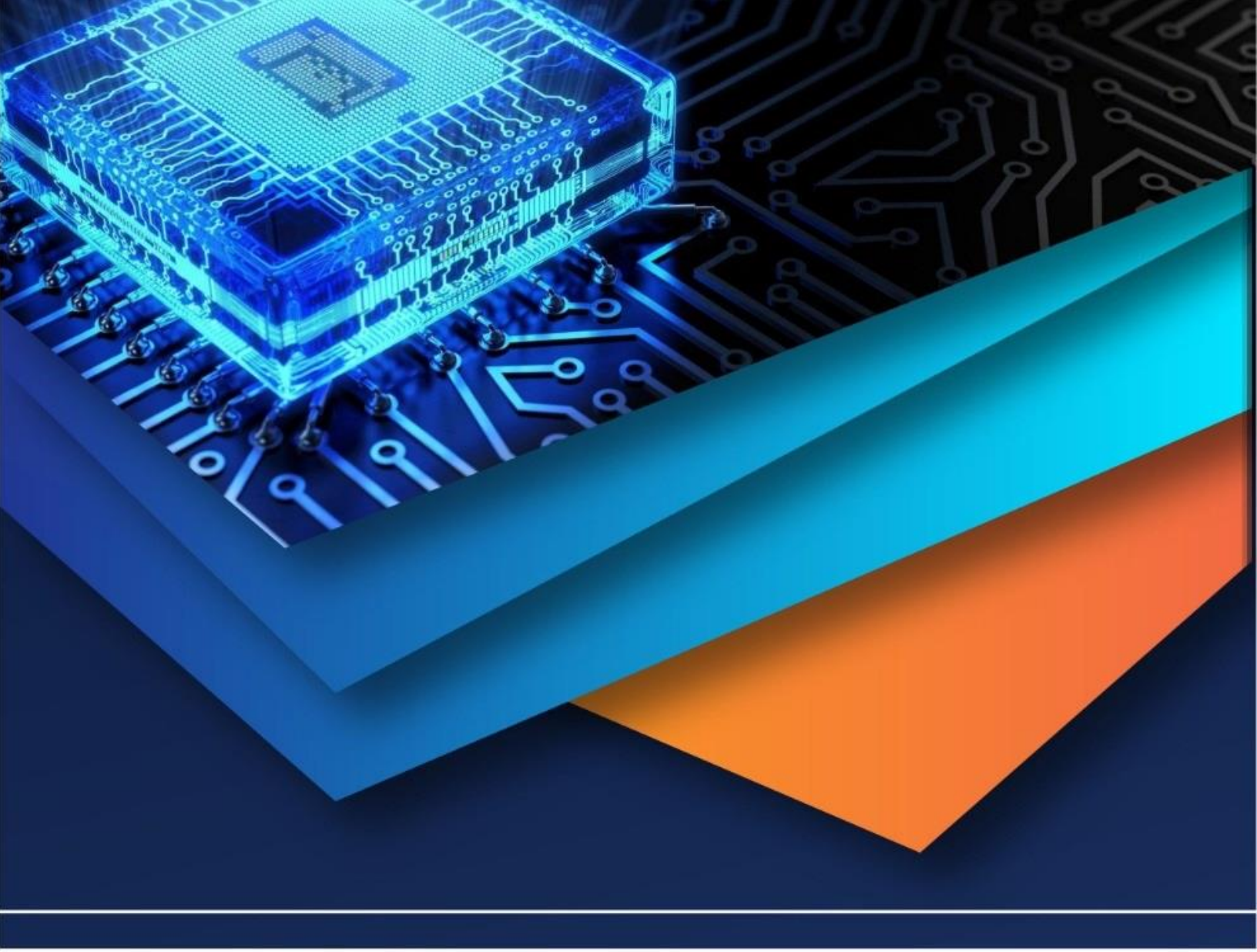

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