New Pattern of China's Passenger Car Market Brought by China's Mainstream Hybrid Technology

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Abstract—In 2022, China's hybrid technology has witnessed a blowout growth and development, showing a state of fierce competition. After the hybrid vehicle represented by Li one has been favoured by many consumers, many Chinese automobile brands have joined the battlefield of hybrid vehicles. BYD's DMI, Great Wall Motor's Lemon Hybrid DHT, Chery's KunPeng Power and Geely's Raytheon Hybrid appeared one after another, breaking the hybrid vehicle market monopolized by Japanese hybrid technology. Using qualitative research method, this paper briefly analyzes the working principle and advantages of mainstream hybrid technology in China in recent two years, and looks forward to the future of hybrid vehicles, especially plug-in hybrid vehicles. The study found that in the next few years, the market share of hybrid vehicles dominated by Chinese independent brands will continue to grow, bringing a new pattern of China's passenger car market.

Keywords- Hybrid, Chinese market, HEV, PHEV

1 Introduction

The purpose of hybrid electric vehicle is to reduce fuel consumption and reduce air pollution caused by vehicle exhaust [1]. Hybrid vehicles are the only way for fuel vehicles to transition to pure electric vehicles. Hybrid vehicles inherit the advantages of energy saving of electric vehicles and have the same long mileage as fuel vehicles. When the number of existing charging piles cannot meet the long-distance travel of electric vehicles, hybrid vehicles are a better choice for low-carbon life and travel.

Previous studies have explained the main principles of hybrid vehicles. In traditional fuel vehicles, the thermal efficiency of the engine is usually between 15% - 35%, but few fuel vehicles can keep the engine running in the range of the highest thermal efficiency[2]. In order to reduce the fuel consumption of fuel vehicles at medium and low speed, vehicle enterprises have added a motor and a battery to the vehicle. At medium and low speed, the motor is used to drive the vehicle, so as to reduce fuel consumption. However, in previous studies, the hybrid technology studied is usually Toyota's th system, but Toyota's main product is HEV (hybrid electric vehicle). Under the condition that the direction of global energy conservation and carbon reduction remains unchanged, PHEV (plug in hybrid electric vehicle) which can often drive in EV mode is a better choice. There is not much design for the technical research of PHEV, and the previous research on PHEV technology is usually some old technology.

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In order to study whether plug-in hybrid vehicles, which are more suitable for the global carbon reduction goal, can have a good market in the future. Therefore, this paper makes principle analysis and Market Research on those PHEV technologies which are more mainstream and have development prospects in recent years. Taking China's passenger car market as an example, this paper explores whether China's mainstream hybrid technology can create a new pattern of China's passenger car market.

2 CLASSIFICATION OF MAINSTREAM HYBRID TECHNOLOGY

2.1Series hybrid electric vehicle

Series hybrid electric vehicles, also commonly known as Range-Extended Electric Vehicles, as shown in Figure 1, is to add a generator, energy storage system (ESS), traction motor, inverter and its control system to the traditional fuel vehicle. Generally speaking, the series hybrid electric vehicle we mentioned refers to the electric energy generated by the engine driven generator to drive the motor, and part of the energy is provided by the battery system. The engine does not directly participate in the driving of the vehicle. The advantage of the series hybrid mode is that the engine can always work in the range with the highest thermal efficiency, so as to reduce the fuel consumption of the vehicle [3]. At the same time, the vehicle is driven by the electric energy generated by the engine and the electric energy in the battery, so the vehicle can obtain the same rapid throttle response as the electric vehicle. Moreover, due to the cancellation of the vehicle's gearbox, the problem of gear shifting frustration can be fundamentally eliminated.

But at the same time, the series hybrid technology needs to convert mechanical energy into electrical energy (engine→ generator→ battery), and then convert electrical energy into mechanical energy (battery→ traction) [4]. Because it needs two energy conversions, the overall efficiency will be relatively low. Moreover, when the vehicle is running at high speed, the power consumption will increase significantly, and the engine needs to be started more frequently to generate electric energy, so the fuel consumption will increase significantly. Therefore, the series hybrid is more suitable for driving on congested urban roads rather than on highways.

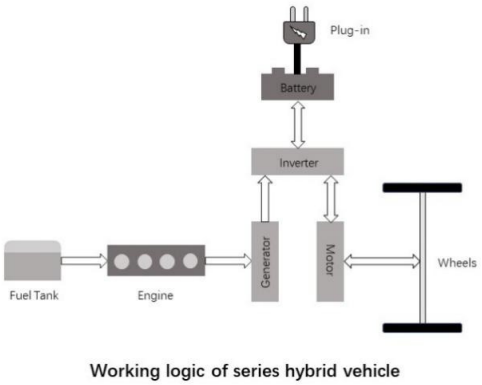


Fig.1 Working logic of series hybrid vehicle

The series hybrid technology is divided into two main schools in China's automobile market. One is the plug-in series hybrid represented by Li One, and the other is the non plug-in incremental hybrid represented by Nissan E-Power. Among them, the sales volume of the ideal one has been stable at about 10000 vehicles per month. The 200 km pure electric endurance and 1000 km hybrid endurance of the ideal one are loved by many Chinese consumers.

2.2Series- parallel hybrid electric vehicle

Series-parallel hybrid is also the main direction of hybrid technology of Chinese car enterprises in 2022. Honda's i-mmd, BYD's DM-I, Great Wall's Lemon hybrid DHT, Chery's KunPeng power and Geely's Raytheon hybrid all belong to Series-parallel hybrid [5]. Compared with the series hybrid vehicle, the engine and motor of the Series-parallel hybrid vehicle can drive the vehicle alone or at the same time, so as to obtain stronger traction. The working principle is shown in Figure 2. When the battery power is insufficient, the engine can also drive the motor to reverse to generate electric energy. The generated electric energy can be used to drive the vehicle or stored in the battery.

When the battery is fully charged, the battery supplies power to the motor, which drives the vehicle. In this mode, the vehicle is no different from an electric vehicle. When the battery is low, there are usually three driving modes of the vehicle, which are intelligently switched by the vehicle's driving computer.

(1) Driving at medium and low speed, the engine drives the motor to reverse to generate electricity. The generated electric energy is used to drive the vehicle, and the remaining electricity is stored in the battery. At this time, the engine can operate in the range of high thermal efficiency. Therefore, even when the battery is insufficient, the fuel consumption of the vehicle is still very low.

(2) Driving stably at high speed, even the engine of the traditional fuel vehicle can run in the speed range of high thermal efficiency [6]. Therefore, the Series-parallel hybrid vehicle can be directly driven by the engine alone. Compared with using fuel to generate electricity to drive the vehicle with a fixed gear ratio motor, direct engine driving the vehicle is undoubtedly a more fuel-efficient choice.

(3) When power output is required to complete acceleration, overtaking and other behaviors, the motor drives the vehicle together with the engine to make the Series-parallel hybrid vehicle reach the maximum output power of the system and meet the driver's demand for power.

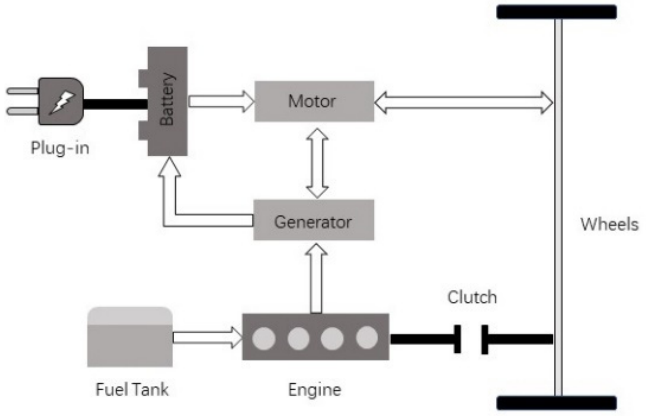


Fig. 2 Working logic of series-parallel hybrid vehicle

In the past two years, these Series-parallel hybrid vehicles released by Chinese auto enterprises are mainly driven by electricity. Usually, electric energy takes up 80% or more of the time to drive the vehicle, so most vehicles have removed the automobile gearbox. When the engine needs to drive the vehicle, the power coupling can be realized by using a single gear clutch with fixed gear ratio. For example, BYD DM-I system cancels the gearbox and uses a single gear clutch. Of course, some Series-parallel hybrid vehicles use two or three gear DHT special transmission in order to have better power when driving at medium and low speed and better fuel economy when driving at high speed. For example, lemon hybrid DHT of great wall motor uses two gear DHT transmission and Kunpeng power of Chery uses three gear transmission. Even so, the transmission gears of Series-parallel hybrid vehicles are much less than those of traditional fuel vehicles, which means better driving comfort.

3 PHEV was once not favored

Until 2021, the monthly sales volume of PHEV has been stable at about 20000. As shown in Fig. 3, the monthly sales volume of China's passenger car market is usually more than 2000000, and PHEV accounts for only 1%. That is, for every 100 passenger cars sold, only one of them is PHEV. There are various reasons for this phenomenon.

Fig. 3 PHEV sales volume in China Market

(1) Need to charge frequently: The battery capacity of PHEV is small, and usually it can only drive the vehicle for about 50km in EV mode. Therefore, if the owner of PHEV wants low fuel consumption, he needs to charge the vehicle frequently. China's charging pile network has been under rapid construction. In the first few years of the construction project, the number of charging piles is not enough to meet the regular charging needs of PHEV owners.For papers with less than six authors: To change the default, adjust the template as follows.

(2) High technical difficulty: The technical difficulty of PHEV is much higher than that of electric vehicle. In addition to saving fuel, PHEV should also do a good job in the superposition and integration of various combined power during vehicle driving, and ensure the smoothness and passenger comfort during vehicle driving. Therefore, car companies have less research and development on PHEV technology, and there are few PHEVs in the market that can take into account fuel economy, power and driving smoothness.

(3) Expensive price: The price of PHEVs is usually much higher than that of similar models or fuel versions of the same model. Due to the high R & D investment of PHEVs and the higher cost of batteries, motors and other electrical equipment, there is a lot of premium for PHEVs that consumers can buy. Most consumers buy new energy vehicles to save money, while the purchase cost of PHEV is too high for most consumers who need to save money.

4 The future of PHEV in the Chinese market

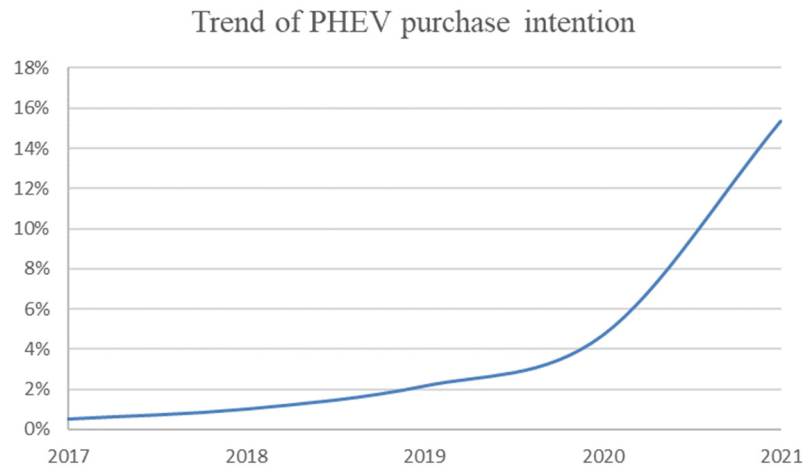
PHEV began to experience explosive growth in 2021. As shown in Fig. 4, the average monthly sales volume increased from 20000 at the beginning of 2021 to 50000 at the end of 2021, and reached 80000 in 2022, more than three times higher than that in 2020. In the coming years, PHEV will become the main force of China's passenger car market. It is the following four reasons that make PHEV become a Mack daddy in the next several years:

(1) Development of Technology: Starting from 2021, Chinese auto enterprises began to make efforts in the field of PHEV and successively released excellent hybrid technologies such as DM-I and LEMOM hybrid, which enabled Chinese auto enterprises to break the silence of PHEV market for many years. The hybrid systems developed by Chinese car companies represented by BYD, great wall, Chery and Geely are mainly series parallel hybrid technology. The hybrid car built by the new technology can give consideration to power, fuel consumption and driving smoothness, and solve a major problem hindering the popularization of PHEV. For papers with less than six authors: To change the default, adjust the template as follows.

(2) Price decline: The manufacturing cost of PHEV has been greatly reduced in recent years, which comes not only from the iteration of technology, but also from the significant reduction of electrification cost. Taking Qin of BYD as an example, the selling price in 2017 was as high as about $30,000, while the latest selling price in 2021 was only about $20,000. It is only thousands of dollars more expensive than traditional fuel vehicles with the same positioning, which is a great attraction for consumers with the purpose of saving money.

(3) Oil and electricity: PHEV takes into account the advantages of electric vehicles and fuel vehicles. It can be charged or driven by fuel. When the vehicle is often charged, the owner can use EV mode to drive, which is a low-carbon and environmental protection choice. Even if it can't be charged, due to low fuel consumption, PHEV's lower fuel consumption and longer range have robbed many consumers from the fuel vehicle market.

(4) Preferential policies: With the progress of strategic objectives such as carbon neutralization and carbon peak, all cities are sparing no effort to accelerate the work of energy conservation and emission reduction. Of course, cars are the focus of remediation. PHEV will become the main income object. At present, the purchase of PHEV will receive the reduction of purchase tax, and the price advantage will be further highlighted. In addition to the purchase tax, PHEV also enjoys many policy advantages, such as preferential vehicle and vessel tax, free vehicle license plate, new energy points and so on.



Source of data: BITAUTO's Research Institute

Fig. 4 Trend of PHEV purchase intention

According to the social research of BITAUTO's Research Institute, the proportion of users with intention to buy PHEV in 2021 is as high as 15.37%, more than three times higher than 4.67% in 2020, showing an explosive growth trend. With the substantial improvement of hybrid technology of Chinese automobile enterprises, the continuous reduction of manufacturing costs such as large-scale battery supply, the icing on the cake such as purchase tax preference, and the active promotion of several Chinese automobile enterprises, the market share of hybrid vehicles will increase unprecedentedly. In 2022, when the monthly sales volume of passenger cars in China decreased by about 20% year-on-year, the sales volume of new energy vehicles increased by about 100% year-on-year, including about 200% year-on-year growth of hybrid vehicles. This phenomenon shows that China's passenger car market is gradually forming a new pattern, a market pattern in which new energy vehicles are the main force and plug-in hybrid vehicles replace fuel vehicles.

5 Conclusion

In this paper, the qualitative research method is used to briefly analyze the working principle and advantages of China's mainstream hybrid technology in recent two years, and look forward to the future of hybrid vehicles, especially plug-in hybrid vehicles. It is found that: (1) the current mainstream hybrid technology in China, including series hybrid technology and series parallel hybrid technology, will make hybrid vehicles more competitive than traditional fuel vehicles. (2) In the next few years, the market share of hybrid vehicles dominated by Chinese independent brands will continue to grow, bringing a new pattern of China's passenger car market. In the future work, we will use a questionnaire to study the more real purchase intention of ordinary consumers for hybrid vehicles, so as to enhance the persuasiveness of our results.

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