Research On Technology Development Status and Trend Analysis Of New Energy Vehicle

Chao Ye\textsuperscript{1,2,*}, Huawei Xu\textsuperscript{1,2,b}, Jianyao Hu\textsuperscript{1,2,c}, Qi Peng\textsuperscript{d,1,2,\*}, Lin Yang\textsuperscript{1,2,\*}

\textsuperscript{1}The fifth electronic research institute of MIIT, Guangzhou, China
\textsuperscript{2}Key Laboratory of MIIT for Intelligent Products Testing and Reliability, Guangzhou, China
\textsuperscript{\*}Corresponding author e-mail: lyny@ceprei.biz, \*yechao@ceprei.biz, b\textsuperscript{xhw@ceprei.biz, c\textsuperscript{hujianyao@ceprei.biz, d}\textsuperscript{pengqi@ceprei.biz}

Abstract. In recent years, with the high awareness of the Chinese government on environmental protection, and support to the development of new energy, new energy vehicles have got developed to a certain extent and have grown into a new field where engineering machinery and new energy are closely integrated. Compared with fuel vehicles, new energy vehicles have great advantages in terms of environmental protection, the only disadvantage is that the engine's power and stability still need to be discussed in depth. Based on the analysis of new energy vehicle development technology in china, this article will further study on the development trend and key research directions of new energy vehicle technology.

1. Introduction

With the development of the economy, the occupancy rate of family cars has gradually increased, cars have become an important means for people to transportation and travel. However, oil as the most important energy source for automobiles is decreasing, and the following environmental pollution problems, people are increasingly aware of the importance and urgency of environmental protection. Therefore, new energy vehicles that reduce exhaust emissions and improve energy efficiency have become key development directions.

At present, new energy vehicles mainly include hybrid, pure electric and fuel cells [1-3]. Hybrid electric vehicles are the first to develop. When the battery capacity is large, they can use pure electric driving mode to improve the efficiency of energy utilization and reduce the emissions pollutants. However, there are technical barriers such as the difficulty of engine design and the complexity of energy management system. Driven by the policy, the pure electric vehicle technology develops rapidly, especially the battery technology, which makes the endurance mileage of some vehicles reach 600km, fully meeting people's travel needs. However, the construction of charging facilities, charging speed and recycling of batteries also bring some challenges to its development. Fuel cell is the development trend in the future, with high energy conversion efficiency and no pollution. But a series of problems, such as high cost of hydrogen production, strict storage requirements, and construction of hydrogenated power station, also restrict its development to a large extent.

Based on the analysis of the current technical principles and development status of new energy vehicles, this paper analyzes the development trend of new energy vehicles, including the change of...
Vehicle quality, the change of charging mode, the combination of electrification and networking, and the key vehicle components such as batteries and motors. The purpose is to provide guidance for the subsequent development of new energy vehicles, further reduce the energy crisis and environmental pollution caused by automobiles.

2. Technical principles and development status of new energy vehicles

2.1. Hybrid vehicle

The power source of hybrid electric vehicle is not unique. It mainly uses electric motor and traditional fuel as a kind of combined power [4]. The development and popularization of hybrid electric vehicle is much faster than pure electric vehicle. The common hybrid electric vehicles in the market are mainly oil electric hybrid vehicles, which can not only reduce the consumption of traditional energy fuel vehicles, achieve the purpose of energy saving and emission reduction, but also make up for the shortcomings of battery energy shortage caused by pure electric vehicles, and enhance the practicability of vehicles.

| Table 1. SWOT analysis of Chinese hybrid electric vehicle |
|---|---|
| **Strengths** | **Weaknesses** |
| 1. Low fuel consumption and emission | 1. Higher technical requirements, such as electronic system performance |
| 2. Long battery life and low cost | 2. Complex structure, with two sets of power system and power management control system |
| 3. No more investment in infrastructure; | |
| 4. Relatively mature application technology | |
| **Opportunities** | **Threats** |
| 1. Suitable for large-scale promotion in cities | 1. Reduced attention due to policy shift to blade electric vehicles |
| 2. Large market potential and few restrictions | 2. Large technical barriers and weak independent research ability |

2.2. Blade Electric Vehicles

Pure electric vehicles do not rely on other fuel energy, directly through the way of electric drive to ensure the movement of the internal machinery in the car, that is, to drive the engine of the car by electric motor [5]. In this driving mode, it is generally necessary to install electric power storage device, which is also one of the technical difficulties that pure electric vehicles are difficult to popularize. At present, the design of electric endurance system and electric power performance of electric vehicles is the difficulty of the development of pure electric vehicles.

| Table 2. SWOT analysis of Chinese pure electric vehicle |
|---|---|
| **Strengths** | **Weaknesses** |
| 1. Zero emission, high energy efficiency | 1. Key parts depend on import and the price is high; |
| 2. Low noise, and smooth operation; | 2. Small energy storage ratio, short service life and high production and use cost |
| 3. Simple structure and convenient maintenance; | 3. Short driving distance and long charging time |
| 4. Low voltage charging at night, saving energy and cost | 4. Operation depends on infrastructure construction such as charging station |
| **Opportunities** | **Threats** |
| 1. No consuming oil, reducing oil dependence and improving national energy security | 1. Limited to weak basic research, high production cost and backward construction of supporting facilities. Difficult to change in the short term; |
| 2. National policy support, the main development direction in the future | 2. The market scale is small, the popularity of users is low, and the promotion is difficult |
2.3. Fuel Cell Vehicle

Compared with the battery, the research on Chinese fuel cell is still in the primary stage. At present, the main focus is on the research of hydrogen fuel cell, but for the instability of hydrogen itself, this fuel cell technology has not been widely used [6]. Fuel cell vehicles generate energy between hydrogen and oxygen through anaerobic chemical reaction, which not only meets the technical requirements of new energy vehicles, but also can make full use of clean energy and promote the good development of low-carbon economy. In terms of future application demand, the development prospect of fuel cell vehicles is much higher than that of pure electric vehicles and hybrid electric vehicles. The reason is that fuel cell vehicles do not need to be charged frequently, but only need to increase fuel to maintain the continuous power of vehicles. It is worth mentioning that hydrogen storage is a more difficult problem at present. The research on fuel cell in China is just beginning. Maybe this new energy vehicle technology will be widely promoted in the future.

### Table 3. SWOT analysis of Chinese fuel cell electric vehicle

| Strengths | Weaknesses |
|-----------|------------|
| 1. Zero emission, higher energy efficiency | 1. The production, storage, transportation and filling of hydrogen are complex and expensive; |
| 2. High specific energy and power | 2. Long starting time and high safety requirements; |
| 3. Convenient energy supplement and short time | 3. The infrastructure construction of hydrogenation station is almost zero; |
| 4. Low noise and stable operation | 4. The technology is still in the experimental stage; |

| Opportunities | Threats |
|---------------|---------|
| 1. The future development direction of automobile industry | 1. The conditions of commercialization are insufficient; |
| 2. The State supports the development of fuel cell technology; | 2. Higher cost and technical requirements |

3. Research on the development trend of new energy vehicles

3.1. Vehicle lightweight

Reducing the body mass is an important way to reduce energy consumption and an effective measure to achieve sustainable development. The research shows that the fuel consumption of the internal combustion engine vehicle can be reduced by 6% - 8% for every 10% reduction of the body mass. The lightweight of the new energy vehicle has a positive significance for the improvement of the endurance and power performance [7].

At present, there are many applications of light alloy (mainly magnesium aluminum alloy) in the field of automobile manufacturing, but the application of composite materials needs to be further strengthened. The manufacturing technology involved in the lightweight design of new energy vehicles is laser welding technology, which can guarantee the welding demand of some lightweight materials, but the technology has some difficulties, so the application in the field of new energy vehicles in China has not been popularized. In the future, new energy vehicle technology will also focus on the research of modern automobile manufacturing, to meet the needs of the rapid development of new energy vehicles.

In addition, vehicle lightweight is not only the lightweight of vehicle body, but also the lightweight of transmission equipment, battery, etc. Lightweight also needs to be combined with the structural design of the vehicle to ensure the strength and performance of the structure, and improve production efficiency and economy.
3.2. Lithium ion battery become the first choice

Battery is the power source and energy storage device of electric vehicle, so battery system is the key part of electric vehicle. Electric vehicles commonly used power batteries including lead-acid battery, nickel hydrogen battery and lithium-ion battery [8].

As a new type of chemical power supply, lithium-ion battery has the following outstanding advantages: the working voltage of single battery is high, so the consistency requirements of battery pack are lower than that of lead-acid battery and nickel hydrogen battery, which can improve its service life; the weight is light and the specific energy is large, which can reduce the quality of the whole vehicle and increase the mileage; the volume is smaller under the same capacity, which can greatly increase the application range. It has long cycle life, up to 2-3 times of lead-acid battery; low self-discharge rate, less than 5% per month. In addition, it has the advantages of wide voltage range, no memory effect, environment-friendly, etc. Based on these advantages, it’s recognized as the most potential electric vehicle power battery.

3.3. Permanent magnet synchronous motor becomes the mainstream

At present, the motors used in the drive system of electric vehicles are mainly switched reluctance motor, induction motor and permanent magnet synchronous motor [9].

Switched reluctance motor has a special structure with different pole numbers of stator and rotor, the excitation winding is concentrated on the stator, the rotor does not have permanent magnet, the starting current of switched reluctance motor is smaller than other motors, and the energy conversion rate is high, but it has the disadvantages of large torque ripple and current fluctuation, so it is necessary to suppress the torque ripple of switched reluctance motor in order to improve its applicability.

Induction motor uses rotor winding induction current and air gap rotating magnetic field to realize the conversion between electrical energy and mechanical energy. The advantages of induction motor are simple structure, small size, light weight, wide speed range and low manufacturing cost. However, the application of induction motor in the control system of electric vehicle will have the problems of insufficient power density and heat generation. At the same time, the performance of induction motor will change with the change of motor parameters and load.

The permanent magnet synchronous motor is developed from the wound rotor synchronous motor. The permanent magnet is used to replace the electrically excited rotor, so the structure of the motor is simple. Because there is no excitation current and mutual friction is reduced, the reliability of the motor is better and the maintenance is more convenient. Permanent magnet synchronous motor has the advantages of fast dynamic response of electromagnetic torque, strong overload capacity, three times of rated torque and high-power factor. The performance comparison of the three motors is shown in table 4.

Compared with other motors, permanent magnet synchronous motor has more reliable performance, higher working efficiency, less energy consumption and longer service life, which can better meet the...
requirements of new energy vehicles in different driving environments. Therefore, it will become the mainstream motor development in the future.

| Parameter                  | Switched reluctance motor | Induction motor | Permanent magnet synchronous motor |
|----------------------------|---------------------------|-----------------|-------------------------------------|
| Speed range (r/min)        | >15000                    | 12000–20000     | 4000–15000                          |
| Peak efficiency (%)        | 90                         | 94–95           | 95–97                               |
| Load efficiency (%)        | 78–86                      | 87–92           | 92–97                               |
| Overload capacity (%)      | 300–500                    | 300–500         | 300                                 |
| Power factor               | 0.60–0.65                  | 0.82–0.85       | 0.90–0.93                           |

3.4. Charging mode changes

The charging speed of new energy vehicles has always been the focus of customers’ attention. The emergence of early high-power charging piles did alleviate users’ anxiety to a certain extent, but there are some shortcomings such as large investment, remote construction location, maintenance difficulties, etc. With the popularity of new energy vehicles, these problems are more prominent. Therefore, it’s urgent to carry out research on more convenient charging methods.

The vehicle charger is a part of the whole new energy vehicle, which can convert the domestic 220V AC mains power into DC power and be used to charge the vehicle power battery. Especially in the evening, it can also use the advantage of low electricity price at night to reduce the charging cost, so it has strong practicability and convenience [10].

The indexes of vehicle charger mainly include efficiency, cost, reliability, etc. Improving the efficiency and reliability, and reducing the cost are the focus of current research. At present, the full load efficiency of commercial vehicle charger is generally low, only about 90%. It is necessary to provide a new design idea to improve the efficiency of charger to more than 94.5% under the condition of low cost. High-performance wide band gap power electronic devices (such as SiC devices and Gan devices) has higher operating frequency, which can reduce the volume of passive components and improve the power density of products. However, due to the high cost of devices, there is no condition for large-scale promotion. The integrated design of vehicle charger is a new trend at present. For example, if the resonant inductor and transformer are integrated on one magnetic core, the volume of the device can also be reduced and the power density can be increased. However, higher requirements are put forward for the design process and control method of the device.

In addition to the traditional wired plug-in charging mode, the research on wireless charging technology of electric vehicles has also attracted more and more attention [11]. No cable is needed to connect the car with the power supply system, and the charging source can be buried under the ground, which can effectively reduce the harm of rain water and electrical contact wear. At present, the commonly used wireless charging methods in electric vehicles include: electromagnetic induction, strong coupling electromagnetic resonance, radio wave, etc. However, wireless charging technology still has some shortcomings, such as low efficiency, short charging distance, inconsistent standards, poor system compatibility and so on.

3.5. Integration of electrification and networking

Vehicle to everything (V2X) is a new communication technology that connects vehicles with everything, in which V represents vehicles, and X represents any object that interacts with vehicles [12-13]. At present, X mainly includes vehicle, people, roadside infrastructure and network. The information mode of V2X interaction includes: vehicle to vehicle (V2V), vehicle to infrastructure (V2I), vehicle to pedestrian (V2P), vehicle to network (V2N).

V2X intelligent network connection system is composed of intelligent road test system, intelligent vehicle OBU, switch, cloud platform and intelligent transportation equipment, as is shown in Fig2.
With the development of V2X and 5G technology, the features of greater data throughput, lower delay, higher security and more massive connectivity, etc. have greatly promoted the development of intelligent driving and intelligent transportation. Through the "car road cloud" collaboration, on the one hand, it promotes the rapid development of intelligent Internet connected vehicles to provide a safer and more intelligent way to travel; on the other hand, it enables the comprehensive perception of intelligent road conditions, dynamic collaborative traffic control and other functions to lay the foundation for the intelligent transportation. It is a great significance to improve traffic efficiency, save resources, reduce pollution, reduce accident rate and improve traffic management.

![System architecture of V2X](image)

**Fig 2. System architecture of V2X**

### 4. Conclusions
From the current severe situation of fuel energy, new energy vehicles will become the focus of future development. Based on the analysis of the principle and research status of new energy vehicle technology, this paper forecasts the development trend technology of new energy vehicles, including vehicle lightweight, lithium battery as the first choice, permanent magnet synchronous motor as the mainstream, diversified development of charging methods, integration of electrification and networking, etc., which will guide the development of electric vehicle technology in the future and realize the sustainable development of clean energy in China.

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