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Analysis of energy-saving principles and development prospects of new energy vehicles

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Abstract. This paper mainly studies the basic principles and application development analysis of energy consumption saving of new energy vehicles in a general scope. It adopts basic comparative research methods to present the advantages and disadvantages of several types of automobiles with different principles and usage methods, taking pure electric vehicles(PEV), plug-in hybrid electric vehicles(PHEV), and Fuel cell electric vehicles (FCEV) as the objectives for research. The conclusion of the study is to explore the breadth and practicality of the prospect application of new energy vehicles. The significance of the research lies in the industry changes brought about by the application of new energy technology in the automotive field and the practical impact on the transformation of traditional methods. It also highlights the research limitations surrounding empirical data, the challenges of the adoption of new vehicles, and the scope of the author's literature research. The future research direction, is also pointed out based on the above three limitations.

Keywords: New energy vehicles, automobile industry, Pure electric vehicles, Plug-in hybrid vehicles, Fuel cell vehicles

1. Introduction

Since the second Industrial Revolution, the automobile industry has developed rapidly, but at the same time, it has also led to a large amount of fossil fuel consumption, which has led to a large number of greenhouse gases and harmful gases emissions, such as carbon dioxide, carbon monoxide, nitrogen oxides in automobile exhaust. This aggravates global warming seriously affects the ecological environment. Therefore, many countries have implemented new energy vehicles (NEVs) as alternatives to conventional vehicles to reduce the dependence on oil and air pollution caused by conventional vehicles [1]. This research delves into the study of these NEVs.

2. Classification of new energy vehicles

Pure electric vehicles PEV/BEV: Pure electric vehicles refer to electric vehicles that are completely powered by power batteries. The on-board power supply is the power supply, and the wheels are driven by the motor, which meets the requirements of road traffic and safety regulations.

Plug-in hybrid car PHEVPlug-in hybrid refers to a vehicle that can be driven by both electric power and traditional fuel. It is a model between a traditional gasoline vehicle and an electric vehicle.

Fuel cell vehicles emerged in the late 1970s. It used fuel cells as the power source and generated electric energy to drive the motor through hydroxide reaction to drive the vehicle.

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3. Working principle of new energy vehicle power system

3.1. Pure electric vehicles

Pure electric vehicle are composed of a drive motor system, a power battery system, and an electronic control system. The drive electric system includes the motor and the drive controller [2]. The motor mainly assumes the functions of electric and power generation under the electric vehicle. It mainly plays the function of the motor during normal driving, converts the electric energy into mechanical ability, and mainly plays the role of power generation when decelerating and downhill, and converts the inertia of the wheel into electric energy. The drive controller is the central computer command and the speed signal and current feedback signal of the motor control the speed, driving torque and rotation direction of the motor. The drive controller and the motor are used together. The power battery system means that the power battery is the power point of the electric vehicle. The performance of the battery system directly affects the acceleration performance of the vehicle and the efficiency of braking performance recovery [3]. The battery of electric vehicles generates a lot of heat during use. The battery temperature affects the operation of the battery, which has an impact on the power, energy, charging, safety, etc. of the battery. In order to achieve the best performance, the temperature of the battery must be controlled within a certain range.

The electronic control system is that the brain of an electric vehicle is composed of various systems. Each system is composed of sensors, signal processor computers, actuators, circuit diagnostics, etc.. When the battery output current drives the motor through the computer when the car is driving, the motor output torque drives the wheels forward and backward. The working principle of pure electric vehicles consists of the battery to the power regulator to the motor to the power transmission system. The current provided by the battery is output to the motor through the power regulator, and the motor provides torque to realize the driving of the car.

3.2. Plug-in hybrid electric vehicles

The plug-in hybrid electric vehicles has a gearbox. Its engine not only provides power, but also drives the car when the battery is out of power. The rangefinder system installs an internal combustion engine rangefinder on the vehicle, but this internal combustion engine is not directly involved in driving the vehicle, but is only responsible for generating electricity for the vehicle. The electrical energy it generates not only directly powers the drive motor, but also charges the battery [4]. When the battery is fully charged, the internal combustion engine can stop working, and the battery directly drives the motor to push the vehicle forward. Therefore, this internal combustion engine can be regarded as the “power bank” of the vehicle. Plug-in hybrid power is composed of two power systems, motor drive and engine drive. Plug-in hybrid is a hybrid car that can be charged externally. To some extent, it is the “fuel-saving version” of the fuel car, because it can be charged and refueled. Generally, it is driven by an electric motor at the beginning. At a certain speed, the engine intervenes and begins to work. Of course, there are also two systems driven together. During driving, when the power battery is powered, the variable frequency motor can generate electricity to supplement the power battery. At present, plug-in hybrid vehicles have three power systems, namely, series hybrid power system, parallel hybrid power system and parallel hybrid power system.

3.3. Fuel cell vehicles

Generally speaking, the driving mode of a hydrogen fuel cell vehicles is to react with hydrogen and oxygen in the fuel cell reactor, generating electrical energy to drive the motor, and finally transmit the torque to the driving wheel through the power transmission mechanism to drive the vehicle. The work of fuel cell vehicles has the following 6 steps:

(1) The process of introducing oxygen

Oxygen enters through the forward gas grille and reaches the fuel cell.

(2) Hydrogen input process

Hydrogen is released from the hydrogen storage tank and enters the fuel cell.

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(3) Hydrogen-oxygen reaction process

Hydrogen and oxygen react chemically in fuel cells and generate water and electricity.

(4) Power transmission process

After the electrical energy generated by the hydroxide reaction in the fuel cell reactor is transmitted to the motor controller for inversion, AC electricity is generated for the drive motor.

(5) Power transmission process

Under the action of three-phase alternating current, the driving motor generates torque and a certain speed, and realizes deceleration torque through the deceleration mechanism, so as to drive the vehicle.

(6) "Emission" emission process

Hydrogen and oxygen react chemically in the fuel cell reactor to produce the only emission gas "water".

4. Advantages and shortcomings of new energy vehicles

4.1. PEV

(1) Advantages:

The first priority of electric vehicles is to save energy. Because the key energy of electric vehicles is electricity, gasoline will not be used at all. In this case, the pollution emissions of electric vehicles are very small, which is a very good choice for protecting the environment. It is an environmentally friendly travel tool.

b. Electric vehicles use power battery packs and motors to drive power. When it works, it will not cause exhaust gas and does not exhaust pollution, which is "zero pollution";

c. Low-noise electric vehicles do not make noise like transmission cars, and the noise it causes is negligible.

(2) Problems faced by PEV development

a. The range performance of pure electric vehicles is not stable. Pure electric range performance is one of the most important performance parameters of pure electric vehicles, and the range performance of pure electric vehicles mainly depends on the battery capacity. However, the power battery pack capacity of pure electric vehicles is not immutable, but will gradually attenuate with the increase of the number of charging cycles. In addition, the external ambient temperature also has a great impact on the battery pack, which will affect the vehicle's range performance.

b. The energy supply of pure electric vehicles is inconvenient. Although the construction of infrastructure such as charging piles and charging stations is becoming more and more perfect, the energy supply of pure electric vehicles is still inconvenient. One should know that fuel vehicles should not refuel for more than 3 minutes at most, while pure electric vehicles need to take at least half an hour to fully charge.

c. The terminal price is relatively high. Due to the high power battery composition of pure electric vehicles and the large investment in research and development, the terminal price of pure electric vehicles is also relatively high. It can be said that compared with fuel vehicles, pure electric vehicles are not competitive in price.

4.2. PHEV

(1) Advantages:

a. Long range: Due to the large capacity of the power battery of the plug-in hybrid vehicle, it can also receive power from the outside, so it has a long range.

b. There is no need to use fuel to save costs: plug-in hybrid vehicles use electric energy, which is cheaper than fuel, so car owners can save a huge amount of money by using plug-in hybrid vehicles.

c. The hybrid car structure with rich power forms is between the gasoline car and the electric car. On the basis of the internal combustion engine, the motor and generator unit are integrated, which makes up for the economy of the gasoline car and solves some technical characteristics of pure electric vehicles. It can really achieve environmental protection and low noise, long range, rich power characteristics, and

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make up for each other's strengths. Of course, this power system is relatively complex, and it works in series, parallel and hybrid.

(2) Problems faced by PHEV development

a. Two sets of power systems have a relatively high failure rate. Plug-in hybrid vehicles can be oil and electricity. There are engines and gearboxes, as well as electric drives and batteries. There are plug-in hybrid vehicles for fuel vehicles and pure trams. There are also plug-in hybrid vehicles that are prone to failures in fuel vehicles and pure trams.

b. Plug-in hybrid vehicles can indeed use oil or electricity to provide power, but not all plug-in hybrid vehicles can maintain low fuel consumption in the state of power loss, which is subject to technical limitations. The fuel consumption of many brands of plug-in hybrid vehicles is higher than that of fuel vehicles of the same level, which cannot achieve the purpose of fuel saving.

4.3. FCV

(1) Advantage

a. Fuel cell vehicles have high energy conversion efficiency. According to Dyke's test of the NECAR4 fuel cell car, the energy conversion efficiency of its fuel cell stack is 62%. If the energy consumption of the fuel cell engine auxiliary system (accounting for 16.4%) and the energy consumption of the motor and its drive system (accounting for 8.1%), the efficiency from the "fuel tank to the wheel" is 37.7%, much higher than the conversion efficiency of 16%~18% for gasoline engine cars and 20%~24% for diesel engine cars.

b. Strong power. The fuel cell power system adopts the "electric-electric hybrid" technology route, that is, the power cell and the fuel cell are connected in parallel. The lithium battery provides the high power required in unsteady state such as vehicle acceleration and deceleration, while the fuel cell is used to provide output power under stable working conditions. This scheme not only solves the problem of slow dynamic response of fuel cells, but also greatly extends the life of fuel cells and provides strong power.

(2) FCV Problems faced by FCV development

The manufacturing process of fuel cells requires the use of precious metals such as platinum as catalysts, and the manufacturing cost is high [3]. In addition, fuel cell vehicles are still in their infancy and have not formed large-scale mass production, so their costs are not easy to be reduced.

5. Supporting charging equipment and charging principle

The basic principle of charging is to turn alternating current into direct current and charge the battery. It can be understood as: (1) The power grid is the power supply, which provides AC power, and the battery charging must be DC; (2) The AC power cannot directly charge the battery, and it must be equipped with a charger to achieve charging. The principle of electric vehicle charger is the same as that of mobile phone chargers. The difference is that the battery capacity of the electric car is much larger than that of the mobile phone, so the charger is much larger than the charger, and there are more auxiliary functions.

6. Development prospects of new energy vehicles

In the future, new energy vehicles will pay more attention to sustainability and the reduction of carbon footprint. The concept of green environmental protection will become an important guarantee for the development of the new energy vehicle industry. New energy vehicles will be deeply integrated with renewable energy, intelligent power grid and intelligent transportation [4].

7. Conclusion

This paper studies the basic principles and application development analysis of energy consumption saving of new energy vehicles. It compares the advantages and disadvantages of several types of vehicles with different principles and usage methods, such as pure electric vehicles, plug-in hybrid vehicles, and fuel cell vehicles. The paper concludes that new energy vehicles have great potential and practicality in

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reducing oil dependence and air pollution. The paper also discusses the industry changes and social impacts brought by the application of new energy technology in the automotive field [5].

However, the paper has some limitations that need to be addressed. First, the paper does not provide enough empirical data or evidence to support its claims and analysis. The paper mainly relies on theoretical and qualitative methods, which may not reflect the actual situation and performance of new energy vehicles in different contexts and scenarios. Second, the paper does not consider the challenges and barriers that may hinder the development and adoption of new energy vehicles, such as the cost, infrastructure, policy, consumer preference, and environmental impact. The paper may be too optimistic and overlook some of the difficulties and risks involved in the transition from conventional vehicles to new energy vehicles. Third, the paper does not review or cite enough relevant literature on the topic of new energy vehicles. The paper may miss some important perspectives and insights from previous studies and experts in the field.

Based on these limitations, future research can improve by using more quantitative and empirical methods to measure and compare the energy consumption and performance of different types of new energy vehicles. Future research can also explore the factors that affect the development and adoption of new energy vehicles, such as the economic, social, environmental, and technological aspects. Future research can also conduct a more comprehensive and systematic literature review to cover more sources and perspectives on the topic of new energy vehicles.

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