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Research on Double Power System of Engineering Machinery

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ABSTRACT. *With the continuous improvement of China's social and economic level and industrialization, there are more and more infrastructure projects in transportation and other fields, and the number and variety of construction machinery used for these tunnel constructions are also growing at the same rate. However, almost all construction machinery uses diesel engines as a power source, causing fuel waste and environmental pollution problems. Therefore, this paper proposes a dual power system applied to construction machinery, which has two major power sources - diesel engine and electric motor. This paper mainly analyzes the connection mode of the double power system of engineering machinery. According to their respective characteristics, after the comprehensive analysis, the separated series structure is selected as the research object of this thesis. The motor structure is modified to provide an overrunning clutch inside, and the diesel engine and the electric motor are connected by an overrunning clutch. In the environment with small working space, the double power system is driven by electric motor, which not only realizes zero emission of vehicle exhaust, but also protects the health of drivers and construction personnel. Moreover, from the perspective of energy saving and environmental protection, the motor drive system has great advantages. It provides theoretical guidance for the development of double power systems for construction machinery in the future.*

KEYWORDS: *Tunnel, double power system, environmental protection, simulation*

1. Introduction

Energy is the strategic focus of economic development, which is not only closely related to the living environment of human beings but plays a decisive role in the sustainable development of society. With the rapid development of the economy and the continuous improvement of people's living standards, the demand for energy has also increased rapidly. With the rapid development of China's industrialization, energy shortages and environmental pollution problems have become increasingly serious. Engineering machineryDiesel engine-hydraulic system-multi-actuator drive scheme, high fuel consumption and poor emissions, its energy-saving problem has been widely concerned by the industryWith the increasing awareness of environmental protection in various countries, green design has become widely used in developed countries as a new design method. Caterpillar, a world-renowned

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construction machinery and engine manufacturer, has always been committed to providing customers with appropriate solutions and development. Cleaner greener products to reduce emissions, improve energy and fuel utilization, and reduce environmental impact. Recognition and attention. Due to the serious environmental problems we face and the limited global petroleum resources, the development of a new energy source has become a top priority for governments. Hybrid systems have been proposed in this form. Small emissions are widely concerned, reducing the pressure on environmental pollution and energy shortages.

Hybrid technology has been highly valued by developed countries such as Europe and the United States since the 1990s, and has achieved some significant results and progress. The new hybrid excavator uses a diesel engine to compensate for the lack of output of the diesel engine during overload and saves the remaining power. This futuristic excavator has made great strides in reducing fuel consumption and emissions, and has enhanced the efficient use of energy.

This paper is to develop a new double power system that can be applied to construction machinery, which is based on the traditional power system of construction machinery vehicles, so that it can use different energy sources to complete the operation requirements under different environments and working conditions. Breaking through the traditional machinery that often only has one kind of power source. The purpose of the research is to develop a new double power system that allows construction machinery to use different energy sources depending on the operating environment to ensure the reliability of the construction machinery in a special environment without additional energy consumption, while improving the driver's Work environment, protect personal health, improve work efficiency and save energy. It is trying to solve a double power engineering machine used in a special working environment. Compared with the traditional construction machinery, the energy consumption is large and the exhaust gas pollution is serious. The use of electric energy to make fuel for construction machinery is still very cheap. And the motor drive can achieve zero emissions of exhaust gas.

2. Methodology

2.1 The Analysis on the Feasibility of Double Power System on Engineering Machinery

Double power systems differ greatly from traditional power systems in terms of structural design, space layout, exhaust emissions, and economy.

The double power system is equipped with an electric motor based on the original power system. Without changing the basic functions of the original power system, the economy and exhaust emissions are greatly improved. . It is simpler and more flexible than traditional power systems in structural arrangement. In a specific occasion, the separation device can be switched to the motor operating mode to meet the working requirements while achieving zero emissions of the exhaust gas. In today's skyrocketing oil prices and increasing environmental pollution, the

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application of double power systems in construction machinery has great potential.

2.2 Analysis of the Selection dual power system

A hybrid system is a system that combines two or more prime movers with different working principles to work. According to the hybrid drive system connection, and the most commonly used combination of mechanical energy and electrical energy. This articleThe double power system studied is divided into series, parallel, and split. The basis of these three double power systems is introduced below.The principle.

2.1.1 Series Drive System

The series dual power system studied in this paper is mainly composed of diesel engine, electric motor and hydraulic pump. Figure 2.1 is a schematic diagram of a series dual power system. The tandem dual power system has two power sources: a diesel engine and an electric motor. When the vehicle is operating in the field and walking and power is inconvenient, the diesel engine is used to drive the working mechanism. At this time, the vehicle is driven in the same manner as the conventional vehicle. When the vehicle is working in a narrow confined space or a flammable and explosive working environment, the AC power supply of the listed network is connected, and the on-board AC motor drives the working mechanism to ensure the clean environment and safety reliability of the construction machinery vehicle.

In the tandem dual power system, when the diesel engine is used as a power source to drive the vehicle, it is necessary to transmit power to the hydraulic pump through the electric motor. The output shaft of the diesel engine is connected to the rotor shaft of the motor. At this time, the rotor of the motor also rotates with the diesel engine. The excitation magnetic field between the polar phases rotates with the shaft and sequentially cuts the stator windings (corresponding to the windings). The conductor reversely cuts the excitation magnetic field). Due to the relative cutting motion between the armature winding and the main magnetic field, a three-phase symmetrical AC power source whose magnitude and direction vary periodically will be induced in the armature winding. The motor is equivalent to a generator, which will react to the diesel engine and consume diesel engine power, which has an impact on the working performance of the diesel engine. Because the diesel engine is interfered by electromagnetic action, part of the output power is used for power generation, so the energy loss is relatively large, only part of the power is transmitted to On the working machine, the work of the construction machinery vehicle was seriously affected. Most of the construction machinery vehicles are in the field work site. In case of emergency, power supply, lighting, etc. are required. Due to the limitation of the site conditions, it is impossible to obtain the power of the city network conveniently. In the series double power system, the diesel engine can drive the electric motor (in this case, equivalent to a generator) to generate electricity for on-site electrical equipment and lighting, etc. At this time, the construction machinery vehicle is equivalent to a mobile power supply.

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When the motor drives the vehicle through the power supply of the city network, the hydraulic pump is driven by the motor, and the rotor shaft of the motor is connected with the output shaft of the diesel engine. When the motor is working, the output shaft of the diesel engine also rotates, which is equivalent to one load of the motor, so that the diesel engine is running at idle speed. Not only does it waste a lot of power, but it also has an impact on the life of the diesel engine. At the same time, the rotating magnetic field of the motor cuts the magnetic excitation line speed, which affects the output speed of the motor and reduces the output power. It can be seen from the above analysis that when the two main power sources of the diesel engine and the electric motor are working, the hydraulic pump is mechanically connected, and there is no energy conversion process in the middle, and the energy utilization rate is high. However, because the two power sources interfere with each other when working, there is a loss of some energy. Therefore, the series dual power system is suitable for the traveling device and working device of the construction machine which is not required for power.

2.1.2 Series Drive System

2 parallel drive systemThe parallel dual power system has two drive systems: a conventional internal combustion engine system and a motor drive system. The torque can be supplied to the vehicle drive train independently, and can be driven together or separately on different road surfaces. When the car accelerates the climb, the electric motor and the diesel engine can simultaneously provide power to the transmission mechanism. Once the vehicle speed reaches the cruising speed, the car will only rely on the diesel engine to maintain the speed. The motor can be used both as an electric motor and as a generator to balance the load on the diesel engine so that it can operate in high efficiency areas. However, because the diesel engine and the drive wheel are mechanically connected, the diesel engine cannot always operate at the optimum working condition in urban working conditions, and the fuel economy of the vehicle is worse than that in the series. Since there is no separate generator, the diesel engine can directly drive the wheel through the transmission mechanism. This device is closer to the traditional automobile drive system, and the mechanical efficiency loss is similar to that of the ordinary automobile, so it is widely used. The parallel double power system studied in this paper is mainly composed of diesel engine, electric motor, switching device and hydraulic pump.

As shown in the figure, the two main powers of the diesel engine and the electric motor can independently drive the working mechanism through the power switching device, and different driving modes are selected according to the different working places, and the power switching is very flexible. Give full play to the advantages of the parallel double power system and improve the performance of the vehicle. Different from the series dual power system, a power switching device is added, thereby overcoming the problem that the two power systems in the series dual power system interfere with each other. The parallel double power system has two driving energy flow lines, the first one is a diesel engine-switching device, a hydraulic pump-hydraulic system, and the second is an external power source, a motor-switching device, a hydraulic pump, and a hydraulic system [101]. Two independent drive systems are controlled by switching devices to perform their respective

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functions and coordinate work. In a parallel system, the two power systems can work independently, without wasting energy. Therefore, the work efficiency is higher than that of the series type, and the application prospects on the construction machinery are broad. However, due to the large size of the parallel system, the structural layout is limited by space, and the control strategy is more complicated. Therefore, it is more suitable for applications on large construction machinery vehicles.

2.3 Tunnel loader dual power system scheme selection

2.2.1 Types of dual power systems for tunnel loaders

Due to the relatively small space of the mechanical equipment of the tunnel loader and the limitation of the working environment, the shape of the loader itself is relatively small when working in a narrow space for a long time. Consider the above several dual power system drive solutions. The series structure of the split drive system is relatively compact, and the separation of the two power systems is convenient and reliable, and meets the requirements of the tunnel loader. Therefore, we choose the separate drive system series structure as the system connection. When the loader is working in the tunnel, the dust on site is relatively large. If the traditional diesel engine drive mode is adopted, the diesel engine intake quality is degraded in the limited space of the tunnel, and the combustion is insufficient, which makes the exhaust gas emission quite serious, posing a great threat to the health of the driver and the on-site construction personnel. The double power system can overcome the above problems. According to the specific conditions of the site, the motor drive mode is adopted to achieve zero emissions.2.2.2 Tunnel loader dual power system structure principleThe structural principle of the tunnel loader dual power system is shown in Figure 2.9.

In the double power system, the diesel engine is connected to the electric motor through a clutch (actually an ordinary one-way overrunning clutch), and transmits power to the transmission. The transmission is composed of a torque converter and a gearbox, and the torque converter transmits the power to the transmission. Hydraulic pumps to drive hydraulic system operations. The input shaft and the output shaft of the torque converter are in fluid communication, and there is no rigid connection between the working members. It can eliminate shock and vibration, overload protection performance and starting performance. The output shaft speed can be greater or less than the input shaft speed. The speed difference between the two shafts varies with the torque transmitted. There is good automatic shifting performance and the load increases. The output speed automatically drops, and vice versa automatically; to ensure that the power machine has a stable working area, the transient changes of the load are basically not reflected on the power machine. The external power supply is connected to the motor to make it a working machine when the loader is working in a tunnel or fixed location. When the motor is working, the motor rotor shaft and the diesel engine output shaft can be separated by the front clutch, and the loader system is a pure electric drive system. The function of the control system is to collect and process various sensor signals, transmit the

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converted electrical signals to the solenoid valves, and control the hydraulic system by the solenoid valves.

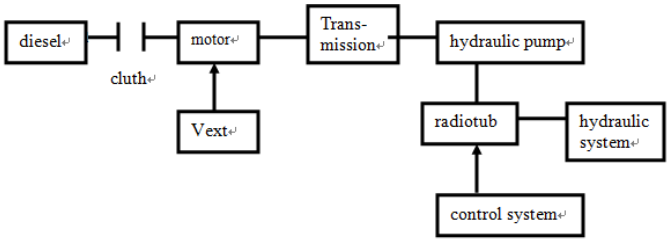

Fig.1 structural schematic diagram of dual power system of tunnel loader

4. Conclusion

With the rapid development of China's economy, environmental issues have received more and more attention. Especially in recent years, the number of cars has increased, making environmental problems more serious. The convening of the Copenhagen Climate Conference in 2009 has once again sounded the alarm for human beings. It is imperative to protect our living environment. As a large oil-consuming household, the construction machinery can not estimate the pollution caused by the environment every year. In order to study energy-saving and emission-reducing construction machinery, various construction machinery manufacturers have turned to hybrid power systems, drawing on the mature technology in the automobile, and referring to a large number of domestic and foreign research. data. This paper studies a double power system and applies it to the loader for simulation analysis. This paper mainly completes the following work:

(1) Analyzed the research results of hybrid systems at home and abroad, and the precedents applied in engineering machinery. With reference to mature hybrid vehicle technology, a double power system applied to construction machinery is proposed. The system is driven by two large power diesel engines or electric motors, and can independently drive the system according to different working environments.

(2) Analyzed the three connection modes of double power system, namely series, parallel and separation. The separation type can be divided into series structure and parallel structure. Considering their respective characteristics, the separated series structure is finally selected. As the research object of this thesis.

(3) The separation scheme clutch and mechanical transfer case of the dual power system are introduced. By comparing and analyzing their respective characteristics, the overrunning clutch is selected as the separation device of the dual power system.

(4) The research analyzes the interaction between the two power systems when they work independently. By installing the separation device and improving the structure of the motor, the diesel engine or the motor can work normally.

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(5) Using MATLAB simulation software to simulate and analyze the double power loader, the simulation results show that the motor-driven loader can also meet the load change requirements. The application of the double power system has changed the narrow construction environment such as tunnels and underground, ensuring the personal health of drivers and construction personnel, and also has important significance for energy conservation and emission reduction.

This article is only some initial work on the research of double powered systems. There are many theoretical issues that need furtherResearch and analysis, so I propose the following suggestions for future work:

(1) This paper only discusses the composition of the double power system with separate series structure. The work of the specific control part has yet to be further studied.

(2) Due to the limitation of conditions, this paper only uses MATLAB simulation software to simulate the whole system, and demonstrates that the double power system is feasible in engineering machinery. There is still a lot of work to be done from the development of the whole vehicle.

(3) The double power system can be used as a mobile power source in an emergency. For this mode of operation, this paper only proposes this concept. The specific implementation requires reasonable matching and conversion of the diesel engine and the electric/generator. Research, therefore put forward higher requirements for the next research work.

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