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# *Product development of an extended cold chain logistics vehicle*

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***Abstract:*** With the continuous development and popularization of the national electric strategy, it also brings a series of problems, among which the mileage has become the most concerned factor for people to choose new energy vehicles. Therefore, this paper briefly analyzes the mileage of electric logistics vehicles in cold chain environment, first describes the relevant models and classification of electric vehicles, and then makes a brief summary of the current situation and existing problems of electric logistics vehicles in cold chain environment. This paper analyzes the reasons why electric logistics vehicles cannot be popularized in batches in cold chain environment, and puts forward corresponding countermeasures and measures for these reasons.

## 1. Introduction

The automobile, as a traditional industrial product, is divided according to the Chinese mainland standard: micro car (displacement is less than 1 L), ordinary class car (displacement is 1.0~1.6 L), intermediate car (displacement is 1.6 and 2.5 L), medium and high-grade car (displacement is 2.5 and 4.0 L), high grade car (displacement is more than 4 L).

The classification of vehicles in our country mainly includes truck, off-road vehicle, dump truck, tractor, special purpose vehicle, bus, car, semi-trailer and so on. The truck is mainly divided into: minivan, light truck, medium truck, heavy truck.

According to the power source, it is divided into new energy vehicle and traditional vehicle, in which new energy vehicle is represented by battery power.

According to the function, it is divided into cargo vehicle and manned vehicle. Electric logistics vehicle has the demand of transportation mileage, volume space and so on. Cold chain logistics vehicle is a vehicle that adds refrigeration and preservation equipment on the basis of logistics vehicle.

Cold chain logistics vehicles are mainly used to distribute seafood, frozen food and other items that need low temperature preservation and some shape requirements. Cold chain logistics vehicle can be divided into small cold chain logistics vehicle and large cold chain logistics vehicle according to its length. Because large cold chain logistics vehicle cannot enter the urban area, it can only be distributed by small cold chain logistics vehicle in the urban area [1]. However, the existing small

cold chain logistics vehicles have the problem of mileage anxiety because of their small driving battery capacity and insufficient mileage.

## 2. Type and classification of electric logistics vehicle

### 2.1 Type and classification of electric logistics vehicles

#### *2.1.1 Electric Vehicles*

1. Hybrid cars, hybrid cars are models that use traditional fuel and are equipped with motors and engines to improve low-speed power output and fuel consumption. According to the different types of fuel, mainly divided into gasoline hybrid and diesel hybrid;

2. Pure electric vehicles, electric vehicles as the name implies are mainly driven by electric vehicles, most of the vehicles are directly driven by motor, some vehicles put the motor in the engine compartment, and some directly take the wheel as the rotor of four motors. The difficulty lies in the power storage technology;

3. Fuel cell car, fuel cell car refers to the car driven by motor, which uses hydrogen, methanol and so on as fuel to produce current through chemical reaction. The energy source of the battery is through the chemical action of hydrogen and oxygen, not through combustion directly into electricity;

4. Hydrogen-powered vehicle, hydrogen-powered vehicle is a real vehicle to achieve zero emissions, discharge is pure water, it has no pollution, zero emissions, rich reserves and other advantages, therefore, hydrogen-powered vehicle is the most ideal alternative to traditional vehicles;

The range increasing car is to add a set of electric vehicles charging device on the basis of electric vehicle. This device does not need to drive the weight of the whole vehicle, but only needs to charge the battery, so it can choose a good economic engine and a set of range increasing device. It becomes an extended electric vehicle [2].

#### *2.1.2 Classification of Electric Vehicles*

Electric vehicles are divided into carrying people and goods, such as buses, while those carrying goods are mini-trucks or minivans, in which cold-chain electric logistics vehicles are goods-carrying vehicles with low temperature requirements in the process of transportation.

### 2.2 Concept and significance of increasing range of electric logistics vehicle

On the basis of electric cold chain logistics vehicle, an additional power generation device is added to charge the driving battery by the extended power generation device, which improves the mileage of the cold chain logistics vehicle and solves the problem of the anxiety of the mileage of the existing electric cold chain logistics vehicle [3]. High temperature water tank and low temperature water tank are included in the heat dissipation device of the high-range cold chain logistics vehicle, and the power performance, heat dissipation performance and emission grade of the driving battery and the extended-range power generation device are improved for the rising emission requirements of six B in the country [4]. Effectively solve the existing cold chain logistics vehicle performance is not good [5].

## 3. Current situation and problems of electric logistics vehicle in cold chain environment

### 3.1 Current situation of electric logistics vehicles in cold chain environment

The size of the truck is 5995 × 2300 × 3400. Although it has large transport space and can be used in shopping malls with high non-basement limits, it is prone to accidents such as overturning, and

there are obstacles to the distribution of underground warehouses and stores. It has been banned from the road in 2021, and its cartons need to be adjusted to 4000 × 2000 × 2000 meters.

The size of the light truck is 5200 × 1700 × 2055 and the internal size is 3240 × 1550 × 1440, which meets the needs of urban operating roads, but the compact space is equipped with at most 50-degree commercial batteries, which can only provide the car to drive for 110km, and the operation process needs to be recharged twice. At least 4 hours a day are spent on charging on the way of operation, seriously affecting the effectiveness of distribution.

## 3.2 Problems of electric logistics vehicles in cold chain environment

Under the actual operating conditions, the range capacity needs to reach more than 220 km.

### *3.2.1 Endurance mileage*

The energy consumption of the cooler is: 3 kilowatt-hours per hour, calculated in 12 hours, the total consumption is 36 kilowatt-hours. The refrigeration of the refrigerator is-18 degrees, it takes 2 kilowatt-hours of electricity to reach the transportable state, and there is energy loss at one time to open and close the door. The energy consumption is about 1 kilowatt-hour in summer and 0.8 kilowatt-hours in winter. Its weight is 1660kg, cold machine 75kg, cold box 200kg, all these will cause the increase of energy consumption.

The space of the model can only be equipped with 50-degree commercial batteries, and the process needs to be recharged, so there is a risk of power loss in operation, so adding a set of extended range system to charge the battery to increase the battery mileage has become the solution.

### *3.2.2 Model space*

In view of the existing fuel vehicles that meet the national six emissions, it is necessary for the engine with a displacement of more than 2.0 to meet the requirements of the whole vehicle performance, but the energy consumption of climbing under low speed and heavy load is not economical [6]. And do not open the cooler to consume more than 100 km 18 liters of oil, poor economy;

For new energy vehicles, to increase the battery capacity and ensure its safety performance, arrange the position of the electric drive axle drive motor and avoid the existing formed engine compartment space in the space where the wheelbase of the chassis (that is, the distance from the front axle to the rear axle) is 2890mm, the width direction hub and hub motor and the brake disc should be arranged, and the space to be able to move is less than 800 mm, Based on thermal conductivity and safety considerations, the battery pack mounting bracket uses cast iron structure to further consume the chassis space, based on which the battery capacity can be arranged within 70 degrees.

## 4. Countermeasures and Measures of Electric Logistics Vehicle under Cold Chain Environment

Different from the existing technology, an extended range power generation device is added on the basis of the small electric cold chain logistics vehicle to charge the battery to improve the mileage ability of the cold chain logistics vehicle, and it is proposed to solve the problem of insufficient service capacity of the existing electric cold chain logistics vehicle. The drive battery, the drive motor and the extended range power generation device are installed directly on the vehicle chassis, and the installation position of the battery is moved forward to the middle or the middle and rear of the vehicle chassis, so that the fuel tank can be installed at the rear of the vehicle chassis, and the extended range power generation device is arranged directly in front of the battery, and the range-increasing power generation device to be arranged in front of the driving battery by moving the position of the driving

battery forward to make room for the front end of the driving battery to install the fuel tank of the range-increasing power generation device, thus enabling the installation of the driving battery and the range-increasing power generation device on the vehicle chassis of the small electric cold chain logistics vehicle.

## 4.1 Increased mileage from the vehicle itself

### *4.1.1 Design of generator*

The drive motor is mounted on the rear axle of the vehicle chassis, the middle part of the rear axle is equipped with differential, the drive motor is connected with the differential of the rear axle to drive the differential, and the differential distributes the power to the wheels on both sides of the rear axle [7]. This model moves the original battery distance 300 mm, so that the rear end distance of the final drive battery is 700 mm, enabling the generator to install a high-voltage tank with a carbon tank solenoid valve (see fig.1).

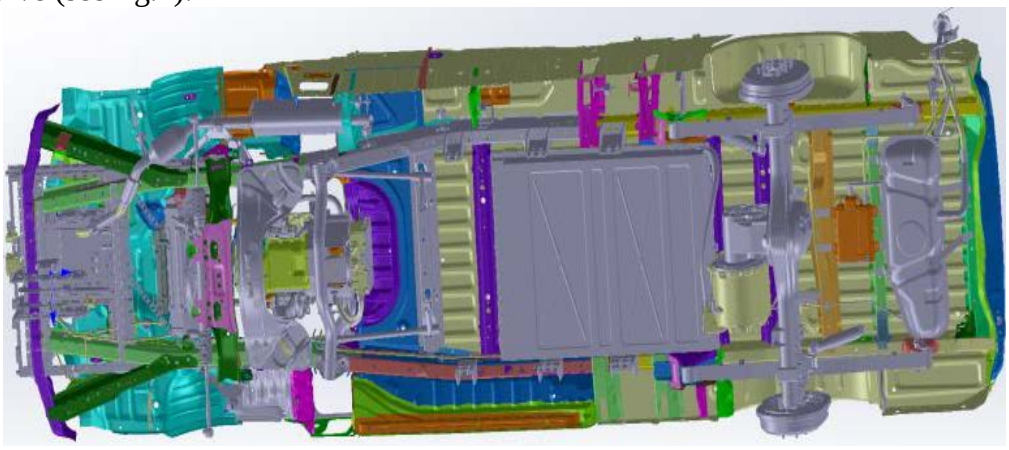

*Figure 1: Three-dimensional chassis model of the extended range logistics vehicle*

In order to sustain the cold chain logistics vehicle, the vehicle is equipped with an extended range power generation device, a fuel power device and a generator, in which the fuel power device can maintain the optimal energy consumption ratio of the generator to generate electricity and charge the driving battery, thus increasing the range of the cold chain logistics vehicle [8].

The driving battery and the extended generation device are connected by the controller of the extended generation device and the whole vehicle controller, thus playing the role of control and failure protection to ensure the normal driving of the cold chain logistics vehicle.

### *4.1.2 Design of Water pump cooled air conditioningdevice*

In order to ensure the power performance of the whole vehicle, it is necessary to effectively control the temperature of the driving battery and the range-increasing power generation device. This range-increasing cold chain logistics vehicle is equipped with heat dissipation device, heat dissipation device for cooling drive battery. The high temperature heat dissipation tank and the low temperature heat dissipation tank are arranged in the power tank at the front end of the vehicle. In order to ensure the heat dissipation area, the heat dissipation area and the heat dissipation speed can meet the requirements of the actual working conditions, the high-temperature water tank and low-temperature water tank have adjustable angle from 5 degrees to 35 degrees. In this way, on the one hand, a small amount of installation space can be effectively used on the chassis of the vehicle, on the other hand, the driving battery and the extended generation device can be effectively cooled.

The heat dissipation device includes a low temperature heat dissipation tank, a high temperature heat dissipation tank and a condenser, a high temperature heat dissipation tank and a low temperature heat dissipation tank are arranged before and after the stack. The high temperature heat dissipation tank drives the battery to dissipate heat, and the low temperature heat dissipation water is used device. The specific distribution is shown in Figure 2.

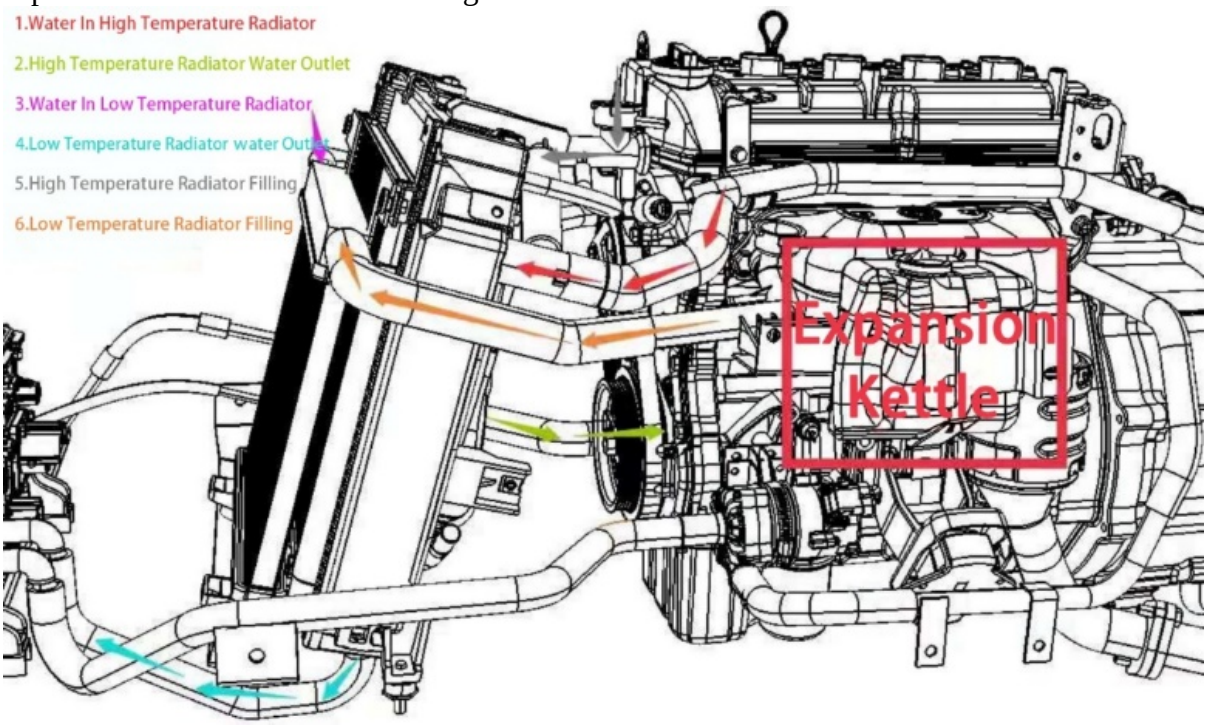


*Figure 2: Water pump cooled air conditioning device*

### *4.1.3 Design and layout of exhaust devices*

The exhaust device is one of the most space-consuming devices, including catalytic converters, shock absorbers and silencers. The catalytic converter is a ternary catalytic converter, and the exhaust pipe is sequentially connected with two ternary catalytic converters and silencers from the head to the tail. The exhaust noise of fuel power device can be reduced by muffler.

Because of the limitation of space, the exhaust pipe can only be installed on the right side of the battery pack, and the clearance from the lowest point of the exhaust device is greater than or equal to 160 mm, which can avoid the loss caused by the pothole pavement and facilitate the passage of the vehicle [9].

Due to the high temperature of the exhaust device at work, when designing the distribution route of the exhaust pipe, the outer wall of the exhaust device (including the outer wall of the exhaust pipe, muffler or catalytic converter) is hung on the rear axle of the drive battery installation. To protect the drive battery from the high temperature of the exhaust device, the overall side of the exhaust pipe is covered with fiberglass insulation cotton, which is a special material that can effectively block the heat transfer of the exhaust pipe to the drive battery. The specific distribution is shown in Figure 3.

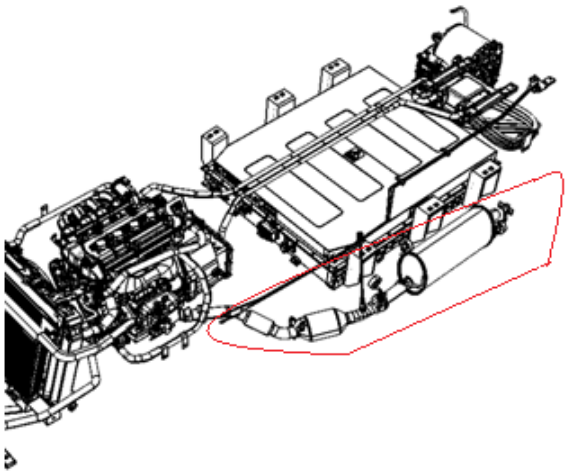

*Figure 3: Distribution map of exhaust pipe*

## 4.2 Analysis of practical effects:

### *4.2.1 Structural design and implementation*

The design of the sample vehicle is shown in Figure 4, using 4-cylinder 1.4 engine, customizing low temperature radiator, multiplexing high temperature radiator, condenser, rearranging heat dissipation pipe to achieve water cooling effect by controlling water flow and direction, using 40 L high pressure tank FTIV valve and carbon irrigation connection double ternary catalytic connection to achieve six B emission reduction parameters and fuel saving effect.

*Figure 4: Chassis Range Extension Structure of Sample Vehicle*

## 5. Conclusions

High-speed cold-chain logistics vehicles include cars, chassis, refrigeration units, driving batteries, driving motors and power generation devices; different from electric vehicles, electric logistics vehicles and cold-chain logistics vehicles;

In order to solve the problem of the mileage of electric logistics vehicle in cold chain environment, the mileage of cold chain logistics vehicle is improved by installing the range booster. And make full use of the disc space, effectively avoid the driving cell and fuel tank position, make the disc layout more reasonable and compact;

Making room at the front end of the driving battery technically by moving the position of the driving battery backward to enable the installation of the high-pressure fuel tank system and the exhaust emission system used in conjunction with the range-increasing power generation device, thereby enabling the installation of the range-increasing power generation device on the vehicle chassis of the small electric cold-chain logistics vehicle;

Through the heat dissipation device, that is, the high temperature heat dissipation tank and the low temperature heat dissipation tank, the high temperature heat dissipation tank and the low temperature heat dissipation tank are arranged in front and back, in which the high temperature heat dissipation tank is used for the driving battery heat dissipation. It will effectively solve the problem of poor heat dissipation and cooling performance of existing small cold chain logistics vehicles.

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## References

*[1] Chen Y, Zhang Y, Wei C, et al. Optimization of extended range electric vehicle energy management strategy via driving cycle identification [J]. IOP conference series. Materials Science and Engineering. 2020, 793(1): 12040.*

*[2] Wang L, Song Z, Wang S, et al. Control strategy optimization and experimental study on startup of range extender for extended range electric vehicles [C]. China: 2017.*

*[3] Geronikolos I, Potoglou D. An exploration of electric-car mobility in Greece: A stakeholders' perspective [J]. Case Studies on Transport Policy. 2021, 9(2): 906-912.*

*[4] Hu J, Javaid A, Creutzig F. Leverage points for accelerating adoption of shared electric cars: Perceived benefits and environmental impact of NEVs [J]. Energy Policy. 2021, 155: 112349.*

*[5] Cetin S, Yenil V. Performance evaluation of constant current and constant voltage charge control modes of an inductive power transfer circuit with double-sided inductor-capacitor-capacitor and inductor-capacitor/series compensations for electrical vehicle battery charge applications [J]. Transactions of the Institute of Measurement and Control. 2021, 43(8): 1710-1721.*

*[6] Liao C, Wang W, Wang J, et al. Magnetron sputtering deposition of silicon nitride on polyimide separator for high-temperature lithium-ion batteries [J]. Journal of Energy Chemistry. 2021, 56: 1-10.*

*[7] Zhang X, Zou L, Cui Z, et al. Stabilizing ultrahigh-nickel layered oxide cathodes for high-voltage lithium metal batteries [J]. Materials Today. 2021, 44: 15-24.*

*[8] Buonomo B, Manca O, Menale F, et al. Numerical Investigation on the Thermal Control of Lithium Batteries for Electric Cars Using Metal Foams and Phase Change Materials [J]. Journal of physics. Conference series. 2021, 1868(1).*

*[9] Ryu S. Mode Choice Change under Environmental Constraints in the Combined Modal Split and Traffic Assignment Model [J]. Sustainability. 2021, 13(7): 3780.*