

# Research on the Design Strategy of New Energy Vehicle Battery Packaging Protection Device in Marine Transportation

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## Abstract

In view of the packaging problems caused by the inconsistent packaging standards, unreasonable packaging structure and structure when serial new energy vehicle batteries are exported to different countries, this paper studies the standardized overall packaging solution of new energy vehicle batteries. The scheme realizes the balance of packaging performance and safety, reduces packaging risk and realizes the goal of ocean transportation. Through the introduction of packaging design, Internet of things technology, FRID and QR code technology to the new energy vehicle battery logistics packaging, a new energy vehicle battery intelligent logistics packaging system is designed, which mainly includes logistics packaging module and intelligent IOT module. Results the new energy vehicle battery intelligent logistics packaging system can not only provide better logistics packaging protection, more efficient logistics efficiency, but also realize the real-time monitoring of packaging, real-time monitoring of the new energy vehicle battery dumping and vibration information, and realize the full traceability of battery quality information. The system can provide more safe transportation package protection and information support for new energy vehicle batteries.

## Keywords

ocean transportation; pressure bearing capacity; shock absorption; Internet of things technology.

## 1. Introduction

According to the report on high quality development of China's Automobile Trade issued by the Department of foreign trade of the Ministry of Commerce, in the first half of 2019, China's new energy vehicle exports reached 5569, an increase of 99.3% year on year, and the average unit price rose by 50.4% year on year. The new energy vehicle battery companies such as Ningde Times, Yutong Bus, Meih energy, BYD, etc. have risen rapidly. With the increase of the export of new energy vehicles, the export of new energy vehicle battery is expanding day by day, and the export of new energy vehicle battery marine transportation is increasingly busy. In the field of new energy vehicle battery product packaging, due to the variety of packaging materials, the complexity of marine logistics and transportation environment, the variety of packaging forms and other factors, the control of packaging problems is often difficult to achieve. As more and more batteries are exported from China to all over the world, batteries are regarded as dangerous goods. Domestic and foreign customs control the export of batteries strictly, which has the dangerous characteristics of explosion and compressed gas. If the displacement of new energy vehicle batteries and other components changes, it will seriously affect product quality, cause more consumer disputes, and seriously trouble manufacturers and consumers. The packaging and transportation mode of the new energy vehicle battery must meet the relevant requirements of the orange book "United Nations

proposal on the transport of dangerous goods", and pass through the small orange book. The risk category is determined by the test in the United Nations Recommendation standard and test manual on the transport of dangerous goods. There are two UN numbers in the orange book for airbags: un0503 safety device and pyrotechnic materials. Many customers don't know what requirements are needed for the export of batteries by sea. The measures such as packaging, limit, mode of transportation, stowage and isolation need to be adopted. They are strictly required in the international maritime transport rules for dangerous goods. To control the risk of new energy vehicles within a certain range, it is necessary to strengthen the packaging according to the characteristics of the risk, control all kinds of risks within the scope of the test rules, in accordance with the United Nations Recommendation standards and test manual on the transport of dangerous goods. In order to control the metal emission and combustion emission hazards, the existing new energy vehicle battery dangerous goods packaging was improved, the pressure test of packaging was carried out, and the intelligent IOT module was added to realize the real-time dynamic monitoring of the new energy vehicle battery logistics information.

## 2. Analysis of Basic Principles of Design

- (1) Design the structure and size of product packaging, and reasonably arrange the location of goods.
- (2) Improve the standard safety efficiency, reduce the logistics transportation cost, and realize the reduction of packaging.
- (3) Study the product packaging process and simplify the intermediate links.
- (4) Finally, complete the new energy vehicle battery standardized overall packaging plan.

## 3. Analysis of Influencing Factors of Packaging Device

- (1) Impact: a sudden change in speed or energy of an object in a very short period of time.
- (2) Characteristics of impact: the action time of impact force is very short; Produce great impact acceleration; have great impact. In the process of circulation, the impact of packaging is mainly vertical impact (drop impact) and horizontal impact.
- (3) Impact during transportation  
The impact of sea transportation and air transportation is related to water area, wind and waves, ship type, load, weather and other conditions.
- (4) Vibration: it refers to the back and forth movement of an object near its balance position. The most basic parameters describing the vibration are frequency, amplitude and phase. The damage caused by vibration to the new energy battery is generally fatigue damage. Generally speaking, the vibration damage is less than impact, so the buffer structure is often designed according to the drop impact height and checked according to the vibration.

## 4. Analysis of Requirements for Battery Transportation and Packaging

- (1) Without exception, these batteries must be transported in accordance with the restrictions in the rules (applicable packaging instructions of DGR 4.2). They must be packed in UN specification package specified in DGR dangerous goods rules according to applicable packaging instructions, and the corresponding number shall be displayed on the package completely.
- (2) For the packaging that meets the requirements, in addition to the mark marked with the applicable proper transport special name and UN number, the class 9 hazard label must also be attached.

## 5. Three Dimensional Pressure Model of Packaging Material Performance Test

In order to accurately describe the dynamic crushing behavior of pressure bearing parts by finite element simulation, the key mechanical properties parameters of the packaging material must be obtained through experimental means. The quasi-static packaging material test of the packaging material at room temperature is carried out. The loading rate of deformation is constant  $3\text{mm} \cdot \text{min}^{-1}$ , and the corresponding strain rate is  $0.001\text{s}^{-1}$ . In order to measure the elastic modulus and Poisson's ratio of the material, the strain in two directions along the longitudinal and transverse directions must be measured at the same time. Because of the non-contact measurement, it avoids the interference of elastic factors caused by the mechanical extensometer or the sticking of strain gauge, and ensures the measurement accuracy of transverse deformation.

(1) Draw a three-dimensional pressure part model in SolidWorks Software, select solid 3dsolid164 as the element of the model, and then divide the mesh of hexahedron and tetrahedron. According to the actual situation, the surface part of the pressure part is impacted, so this part is not constrained, and the bottom part of the pressure part is fully constrained according to the working condition.

(2) Analysis of impact crushing test data

(3) Compared with the simulation results, the results of theoretical calculation and test are in good agreement with each other in terms of crushing form, fragment size and fragment shape.

(4) transient impact simulation of a new type of composite foam bearing part is carried out by finite element simulation. The LS DYNA software calculates the impact fracture of the pressure bearing parts based on the measured performance parameters of the materials. The simulation results of the crushing form, the size and the shape of the fragments are basically consistent with the actual impact fracture test results of the pressure bearing parts. By using the simulation method and results, the method ideas and reference basis are provided for the design and research of battery pressure parts.

## 6. Design of Vibration Isolation and Buffer Structure

Select buffer packaging design buffer material, to produce numerous independent bubbles. It is important to study the dynamic characteristics of vibration isolation buffer structure, to predict the vibration response and to improve the effect of vibration isolation buffer. Due to the difference of vibration isolation buffer material and structure and manufacturing error, and the complexity of nonlinear constitutive relation, it is very difficult to accurately design the buffer structure. The dynamic characteristics of the nonlinear damping and buffer coefficient of the vibration isolation buffer structure should be considered, and the damping and buffer coefficient should be taken as the function of load and frequency, The nonlinear elastic restoring force and buffering performance of the vibration isolation buffer structure are expressed by mathematical expression, which can well describe the nonlinear mechanical characteristics of the vibration isolation buffer structure, lay the foundation for predicting the vibration response and improving the vibration isolation effect, and designing the high-quality vibration isolation buffer structure (as shown in the fig.1).

Cushioning coefficient

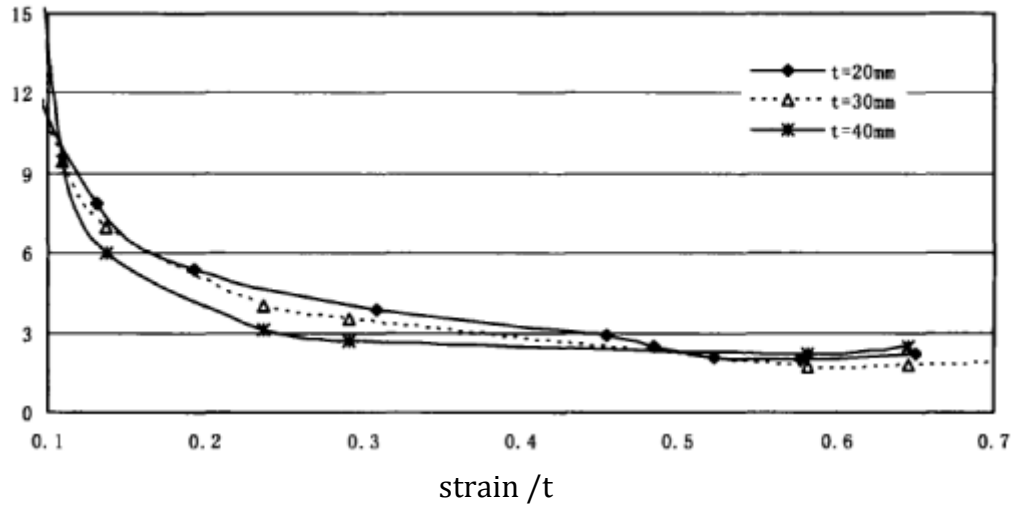


Fig. 1 nonlinear damping and damping coefficient of vibration isolation buffer structure

- (1) Calculate the maximum load weight of the product according to the mass and the maximum drop height of the product;
- (2) Using the curve of strain buffer coefficient, the thickness of vibration isolation buffer material is calculated according to the maximum allowable acceleration;
- (3) According to the elastic properties (strain stress) of vibration isolation and buffer materials, the area of honeycomb paperboard liner is calculated;
- (4) According to the requirements of vibration isolation, the natural vibration frequency range of the system composed of products and vibration isolation buffer materials is selected.

## 7. Design New Energy Battery Protection Device Model of Automobile

The advanced new energy battery protection device of electric vehicle is designed to solve the problems of poor protection effect of new energy battery, easy damage in transportation and long service life of shadow new energy battery. A new technical scheme is adopted: the new energy battery protection device of electric vehicle, including the device body, the bottom of the inner cavity of the device is fixedly connected with a placement plate, and the top of the placement plate is fixedly connected with a placement plate. The top of the placement plate is fixedly connected with a placement plate, the placement pad is movably connected with the battery body, the top and bottom of both sides of the inner cavity of the device are fixedly connected with a slow middle spring, one end of the slow spring far away from the inner wall of the device body is fixedly connected with a protection plate, the top of the device is provided with a plate, both ends of the device top extend to the inside of the box and are sealed. The sealing pad is connected in a movable way. The bottom two sides of the cover plate are fixedly connected with a clamp block, the two parts of the device are fixedly connected with a fixed block, one side of the top fixed block is provided with a positioning rod, and one side of the fixed block is provided with a clamp slot. The positioning rod is effectively connected with the fixing block, the clamping groove and the clamping block in turn, so that it extends to the inner side of the fixing block.

- (1) The clamping pad and protection increase the stability of the clamping block in the clamping groove, the limit rod moves to protect the limit groove and the protection plate of the limit rod, so as to prevent the new energy vehicle battery from appearing in the remaining groove and play an effective protective role.

(2)The utility model improves the stability of the fixed card block in the card slot by setting the card pad and the protection pad, and at the same time, the protection pad can protect the surface of the new energy battery and prevent the damage caused by the collision in the transportation process. When the protection plate moves, the new energy vehicle battery is limited by the limit slot and the limit rod to prevent the new energy vehicle battery from tilting, and the handle is set to effectively protect the box Internal new energy vehicle battery to prevent new energy battery from falling from the box.

#### Cushion packaging design

One material is selected as buffer material, which has high elasticity, its appearance is white, light and flexible, and can be bent. It also has the characteristics of heat preservation, water separation, moisture proof, heat insulation, sound insulation, anti-friction, anti-aging and corrosion resistance. In addition, buffer material has good process ability and impact protection effect. The overall buffer design is adopted in the structure.

## 8. Intelligent IOT Module

The intelligent IOT module applies the Internet of things technology to the marine logistics transportation based on the Internet of things. With advanced information management, information processing technology, information collection technology and information communication technology, it completes the dynamic process of new energy vehicle battery from supplier to consumer, including storage, transportation, loading and unloading, transportation, packaging, circulation and processing, and information Processing. The main functions are as follows:

#### (1) Data collection

The content of information collection is mainly based on market research. The information that needs to be collected on site for new energy vehicle battery logistics packaging is shown in the table, and RFID is pasted on the battery package of new energy vehicles. Electronic label and two-dimensional code, draw real-time curve of logistics information, save and query historical record information, number object information related to new energy vehicle battery, such as product, package, means of transportation, relevant personnel and other information, record object information content in detail through a unified database, transmit information number through wireless communication, and number each with the help of database. It is associated with the detailed information of the monitoring object to improve the data transmission efficiency. When the logistics environment of the packaging device changes, the corresponding sensor system combines RFID. The system transmits the captured information to the monitoring center for processing. If the tilt, vibration and other data are in normal state, it is not necessary to feed back to the monitoring center. If the data is in the early warning stage, the monitoring center feeds back to the logistics management center and field staff through the wireless communication network. It is a monitoring strategy when the vibration frequency of the new energy vehicle battery is too high. The system can not only monitor the logistics status of new energy vehicle battery in real time, but also determine the specific location of logistics vehicles through Beidou satellite navigation and positioning system, and video monitor the status of new energy vehicle battery packaging through the on-site video system.

## 9. Conclusion

With the help of Internet of things, a strategic emerging industry, it can be reasonably applied to the intelligent logistics and packaging system of new energy vehicle battery, intelligent test of packaging material performance, intelligent experiment of cushioning material vibration,



intelligent logistics and packaging system of new energy vehicle battery and logistics and packaging of new energy vehicle battery based on Internet of things and Internet of things technology To innovate the recycling of packaging equipment and advocate the concept of green packaging. The logistics and packaging system of new energy vehicle battery effectively improves the safety requirements of marine transportation and packaging. The dynamic pressure bearing safety tracking of new energy vehicle battery and real-time monitoring of dynamic information play a guiding role in solving the problem of new energy vehicle battery in the process of marine logistics and transportation, which is conducive to the integration of automobile industry resources and optimization of industry transportation of new energy vehicle battery production enterprises transport and logistics packaging system, reduce the degree of logistics hazards, and improve the economic indicators of marine transportation of new energy vehicle batteries.

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