Risk Assessment and Countermeasure Research of Lithium Battery Air Transport

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ABSTRACT

Lithium batteries are used more and more widely and play a role in many fields. However, lithium batteries often cause accidents during air transport. From lithium battery cell production to battery assembly and battery recycling and other steps, six links will involve air transport. At present, domestic and international research on lithium battery only presents an improved method of battery material, but there is less research on the risk of lithium battery air transport. This study is to put lithium batteries into the air transport system to be considered, and made some suggestions.

Key words: lithium battery, air transport, risk assessment, countermeasures

RISK FACTORS OF LITHIUM BATTERY AIR TRANSPORT

In order to effectively carry out risk assessment of lithium battery air transport, we must first make clear the risk factors of lithium battery air transport, understand the complex system of lithium battery air transport and relevant industry characteristics and laws. This paper mainly analyzes the contents of lithium battery air transport accidents, discusses relevant laws and regulations, and analyzes the risk factors of lithium battery air transport.

Lithium Battery Aviation Accidents

An aviation accident took place in 2006 caused tremendous repercussions. At the time an airline had taken off, but its warehouses were alerted. Thanks to the timely disposal of crew, further expansion was avoided. The relevant survey shows that it was lithium polymer battery package caused the fire accident. This package is an electrical part and there is a lack of relevant UN test reports for battery transport in the cargo description. Packing issues and flight environment caused the battery short circuit problem.

In 2009, FedEx found a combustion package containing lithium ion battery GPS positioning device. This accident attracted people's attention. After inspection, it was found that there was no desired label on the package.
The main cause of the accident is packing problem and mechanical vibration. In addition, there are many air transport accidents, mainly lithium battery accident caused by incorrect packaging and testing. In related accidents, most of the reasons are that shippers lack awareness of the air transport of lithium batteries and others have neglected the legal provisions in view of the high cost.

**Lithium Battery Air Transport Regulations**

The regulations of the Civil Aviation Administration of China include the requirements for the carrying form and the carrying quantity of the lithium battery, and the concrete measures is put forward to prevent the short circuit. ICAO and others also put forward relevant requirements. It is required that the packing instruction number of the lithium battery should correspond to the shipping name. In each packing instruction, there are specific shipping requirements and packing requirements, which also include the types of lithium batteries that are forbidden to carry. At present, lithium battery is very easy to enter the air transport. Facing with various types of lithium batteries, we must clearly identify the lithium batteries that can be transported to ensure the correct packaging, so as to avoid accidents [1].

**RISK ASSESSMENT OF LITHIUM BATTERY AIR TRANSPORT**

In order to further analyze the risks during the air transport of lithium batteries, we must not only pay attention to the integrity of risk assessment, but also pay attention to confirm the weight of indicators, continuously realize the quantification of qualitative indicators and the dimensionlessness of quantitative indicators. Weight marks the risk of various indicators, and the weight factor decision method is relatively simple. This article uses this method to determine the weight of the risk assessment index system of lithium battery air transport.

**Weight Factor Decision Method**

The weight factor decision method uses the matrix form to analyze the importance of the relevant factors to target contribution. Set n risk indicators, construct the matrix of N x n, and take the value of the “row” as one, the value of the “column” the other which was compared with. After careful analysis based on this matrix, let scoring experts compare, and 0, 0.5, 1 are used in the matrix for describing. 0 is not important, 0.5 is equally important, 1 is more important. Then the scoring experts are asked to score and test the scoring result.

1. The sum test needs to satisfy

$$T = \frac{n(n-1)M}{2}$$

In the formula, n is the number of risk indicators, M is the highest score, and T is the sum. After testing, if the sum is the correct value, it means the test result is correct, so the complementary test can be continued.

2. The complementary test needs to satisfy

$$a_{ij}+a_{ji}=M$$
In the formula, \( a_{ij} \) is the score obtained when the evaluating indicator \( j \) is compared with \( i \), and the formula \( a_{ji} \) is the same.

After the calculation, the weights can be calculated by examining and counting the scores.

**The Application of Weight Factor Decision Method in the Risk Assessment of Lithium Battery Air Transport**

After weight calculation, in combination with the known risk assessment model, the experts need to score and determine the weight of each risk factor index, and further determine the magnitude of the risk. As in Figure 1, it is an index system of the risk assessment of lithium battery air transport. The supervision of the shipper and the correct identification of transportation are the key risk factors, which need to be paid attention to [2].

![Risk assessment index system of lithium battery air transport](image)

**RISK CONTROL IN LITHIUM BATTERY AIR TRANSPORT**

With the continuous development of society, the recent date of lithium battery air transport confirmed that the lithium battery traffic is increasing gradually. If the risk control is not strengthened, accidents caused by lithium batteries will continue to happen, and as many aviation accidents are closely related to lithium batteries, it is necessary to pay attention to lithium battery air transport and strengthen the management of lithium battery air transport.

**Ensure the Correct Identification and Classification of Lithium Batteries**

According to the analysis of the results of the risk assessment, we first need to ensure that lithium batteries can be correctly identified before entering the aircraft, so that we can
determine whether it meets the requirements of the relevant laws and regulations of transportation. The types and properties of lithium batteries should be clearly identified in the process of recognition and classification. At present, lithium batteries are divided into two broad categories in *Lithium Battery Guidance Document*: lithium metal batteries and lithium ion batteries. Lithium metal batteries are generally non-rechargeable and contain metallic lithium. Lithium ion batteries do not contain metallic lithium and are rechargeable. The regulation for lithium battery air transport is that each package must have a label, so that reasonable transport arrangements can be made. The lithium battery rated watts should be limited not to exceed the specified value, which is important. For lithium metal batteries, it is required that the lithium content of battery cell should not exceed 1 gram, and the reasonable lithium content should not exceed 2 grams. And there are special requirements for the independent packaging of non-limited transport packaging. Be careful to paste the corresponding label so the shipper can see it easily.

**Strength the Supervision of the Shipper**

In addition to the correct classification and identification of lithium batteries, the supervision of shippers is also important, mainly to reduce the risk of lithium battery transport. In the transport of lithium batteries, the shipper is directly related to lithium batteries and other relevant items, so the shipper should be clear of the legal regulations relevant to lithium battery transport, be warned not to consign air embargoed goods, and pay attention to the prohibition of the transport of lithium batteries recalled by the manufacturer. If the shipper is entrusted by someone, either purposeful for transporting waste batteries or recalled lithium batteries to be destroyed, the shipper is required to obtain written permission from relevant agency and must obtain relevant approvals before transport. The transport must be effectively regulated, supervision of the shipper is required, and the basic requirements for avoiding short-circuiting of packaging equipment should be emphasized. Besides, the training of shippers should be taken seriously to make shippers understand the dangers of non-transportable lithium batteries, so as to improve their safety awareness. According to the relevant experience, it is important for some shippers to realize the mistakes of their own behavior by the way of training. Therefore, it is suggested that a number of shippers of lithium battery air transport should be arranged to receive training to ensure the safety of transport [3].

**Reasonably Control the Ambient Temperature of Lithium Batteries**

Lithium batteries will be affected by the temperature, especially the high temperature will lead to thermal runaway of battery cell, so main focus of the internal control of lithium batteries is thermal runaway, and battery cells should be avoided contact with some high heat objects, especially some open fire or hot objects. Dense packed battery pack is easy to lead to thermal runaway, so in the process of large storage, we should pay attention to the isolation between lithium batteries and articles such as oxidizing agents.
CONCLUSION

Faced with the frequent occurrence of air transport accidents caused by lithium batteries, this article analyzes the risk factors and risk assessment. According to the relevant regulations of lithium batteries, the countermeasures to reduce the risk are put forward, which require reasonable control of the lithium battery identification, the supervision of shippers and the ambient temperature.

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REFERENCE