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Study on Recycling and Reuse of Waste Battery of Electric Vehicle

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Abstract.In recent years, with the rapid development of the electric vehicle market, the number of waste lithium ion battery has also risen rapidly. The waste lithium ion power battery contains a lot of toxic and harmful substances, so it is of great significance to recycle and harmless treatment. This paper summarizes the main processing of waste lithium ion battery, including three steps: pretreatment, two treatment and deep treatment. Among them, the two processing and deep processing steps are the core part of the whole process, which has the greatest influence on the recovery effect of the whole battery. Finally, through the comparison of the main wet process and fire process, the process of treating waste lithium ion power battery with wet process and fire method is put forward, and the development direction of the waste lithium ion power battery recycling technology in the future is prospected.

Introduction

With the increasing shortage of global fossil resources and the urgent need of environmental protection, the development of electric vehicles to reduce the consumption of resources and reduce environmental pollution is becoming a widespread consensus. In recent years, the state has made great efforts to support electric vehicles. The output of electric vehicles has risen sharply. By the end of 2017, 1 million 572 thousand electric vehicles were produced in China, and the market ownership was close to 1 million 500 thousand. In 2020, the production and sales of electric vehicles in China would exceed 5 million[1]. A large number of market driven electric vehicles will inevitably bring about the problem of recycling after the termination of battery life. It is reported that the battery life of private car pure electric / plug - in cars is usually 4~6 years, while for buses and taxis, the life span of the battery pack is lower than that of 2~3 years. In 2016, the waste volume of China lithium ion battery is about 5~8 million tons. It is expected to be abandoned in 2020. It's up to 12~17 million tons. Lithium ion power battery contains a lot of valuable metals and organic matter. If it is not recycled, it will cause serious environmental pollution and waste of resources. At present, the recovery and reuse of lithium ion power battery has become the focus of the industry. In January 2017, the State Council issued the programme for the implementation of the extended producer responsibility system, and proposed the requirements for the establishment of an electric vehicle power battery recycling system in the field of new energy vehicles to ensure the recycling and safe disposal of waste batteries [2].

Domestic recycling of waste lithium ion battery has many problems in many aspects, such as law, channel, cost and so on, which hinders the rapid development of recycling market. Battery recycling business in power battery enterprises is still in the stage of planning and testing, and battery manufacturers are developing slowly in power battery recycling. With the increasing number of electric vehicles in China, the number of waste lithium ion power batteries is increasing, which means that it is necessary to establish a suitable waste lithium ion power battery treatment scheme.

Recycling of Waste Lithium Ion Power Battery

The purpose of the recycling and treatment of waste lithium ion power batteries is to effectively separate the components of the battery, to extract the valuable metals in the battery, and to reduce the pollution of the waste to the environment. By summarizing the literature, it is concluded that the

recycling process of waste lithium ion power battery is mainly divided into three steps is shown in Fig. 1: pretreatment, two treatment and depth treatment step [3] [4] .

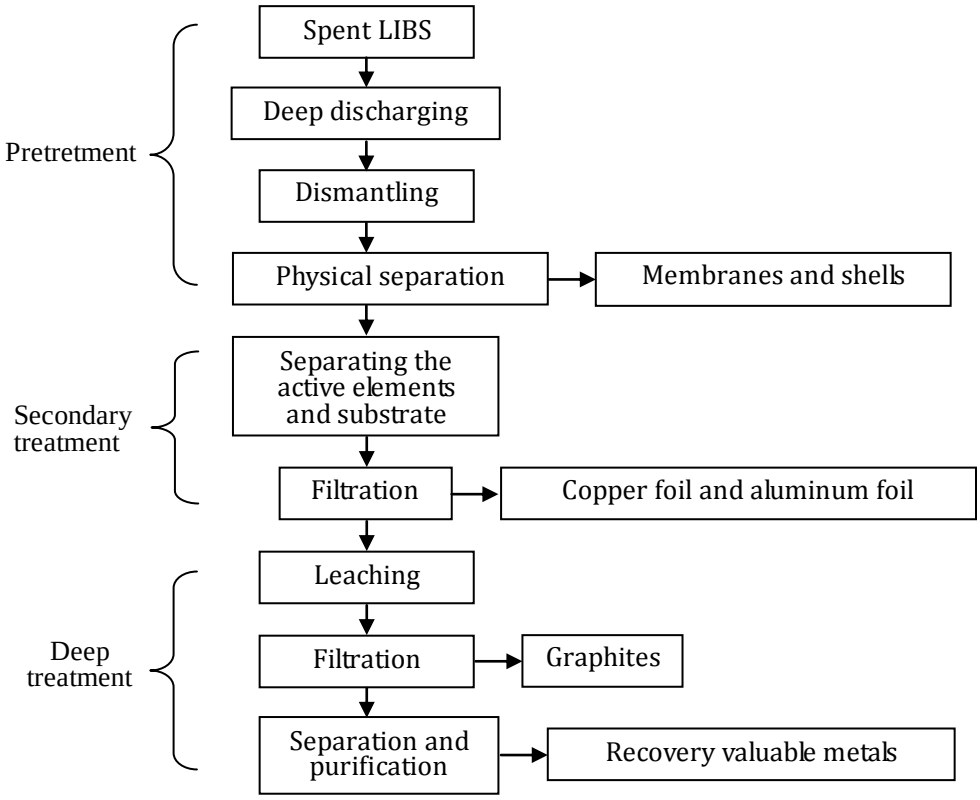

Figure 1. The recycle process of spent lithium ion batteries

Preprocessing step. Although the waste lithium ion power battery has come to the scrap stage, there is still a part of the residual amount of electricity in the battery that is not consumed, so the battery needs to be discharged before the battery recycling. Unlike other batteries, the charge and discharge of lithium ion power batteries will cause some metal lithium to adhere to the positive and negative surface, and the lithium metal is very easy to react with water to produce H_2; in addition, the electrolyte contained in the lithium ion power battery will produce a toxic HF[5]. In view of these conditions, before recovering valuable metals from batteries, it is necessary to pre treat the battery properly, and eliminate these potential risks by. The pretreatment steps mainly include deep discharge process, crushing and physical separation process[6] [7].

Two processing steps. The two step is to achieve the complete separation of positive and negative active materials and substrates. As the negative binder generally uses water-soluble binder, the bond between the negative active material and the copper foil is weak, and the negative pole fragments are placed in the aqueous solution. The strong agitation can achieve the complete separation of the two. The positive electrode binder is a mixture of PVDF and N- methyl pyrrolidone (NMP). Because the amount of solvent NMP is large, the bonding effect between cathode material and aluminum foil is strong and difficult to separate. Therefore, in the process of the two treatment, it is mainly to separate the cathode material from the aluminum foil[8]. At present, the common methods are heat treatment, organic solvent dissolution, lye dissolution and electrolysis. Christian et al put forward a new way to recover the spent lithium ion power battery is shown in Fig. 2.

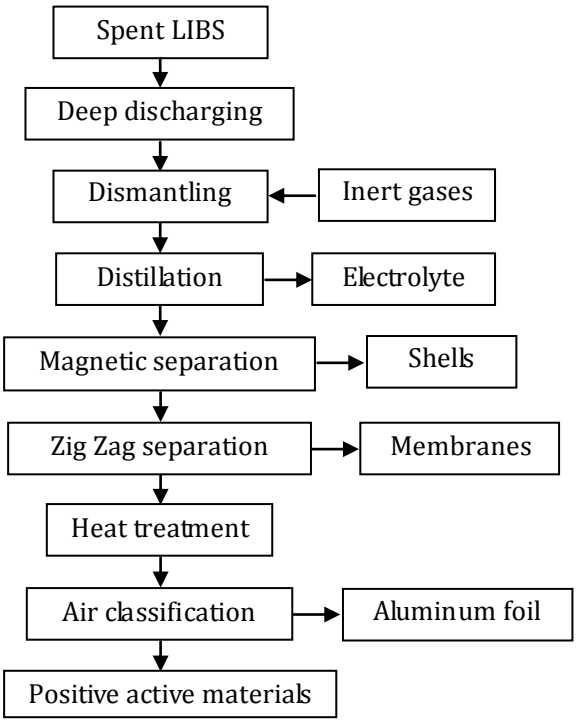

Figure 2. A new process was used to recycle spent lithium ion batteries

Depth treatment steps. The advanced treatment steps include two processes: leaching, separation and purification. There are two ways of leaching. Acid leaching and bioleaching. There are mainly precipitation, extraction and electrochemical methods.

Conclusion

Waste lithium ion battery is a dangerous waste. If it is not handled properly, it will not only pollute the environment, but also affect the health of people and animals. At the same time, the waste lithium ion power battery contains a lot of valuable metals (Co, Ni, Li, Mn, Al, Cu, Fe, etc.). The recovery of the valuable metal in the waste lithium ion power battery can bring a good economic benefit and realize the sustainable development of the resources[9].

At present, the methods of recovering lithium-ion batteries used in industry are mainly based on pyro metallurgical process and hydrometallurgical process. The process of fire metallurgical process is large, the process is simple and the variety of batteries can be treated. However, the high cost of the metallurgical process, the high demand for the equipment, and a large number of harmful gases in the process of treatment. Hydrometallurgical process has low cost, high recovery rate of valuable metals and good process stability. However, the process of hydrometallurgy is long and the amount of treatment is small. A large amount of waste liquid in the process of treatment needs to be further treated for environmental protection. Considering the merits and demerits of the two processes, the research on recycling and recycling of spent lithium ion battery is mainly based on hydrometallurgy and combined process[10]. On the basis of the pretreatment process, the positive electrode was enriched by heat treatment process, and the valuable metal in the waste battery was effectively recovered by the process of acid leaching and extraction.

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