Open Access Journal of Waste Management & Xenobiotics
ISSN: 2640-2718

Recycling Potential for Waste Electric Vehicle Lithium-ion Batteries in China

Mini Review
Volume 2 Issue 4
Received Date: September 17, 2019
Published Date: October 14, 2019
DOI: 10.23880/oajwx-16000129

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Abstract

The number of waste EV LIBs (electric vehicle lithium-ion batteries) has been increasing in China. Reasonable disposal of waste EV LIBs has becoming a new research hotspot. In this paper, the current status of the generation of waste EV LIBs of China is analyzed, and the treatment strategy and recycling market potential of waste EV LIBs are introduced. And some recommendations were given for the existing problems in the waste EV LIBs recycling market.

Keywords: Waste electric vehicle lithium-ion batteries; Recycling; Potential; Cascading Use

Introduction

With the increasingly serious environmental pollution and energy crisis, the EV (electric vehicle) industry has shown vigorous development in recent years. Lithium-ion batteries (LIBs) have been widely used in EVs due to their high energy density, lightweight and long cycle life [1]. A large number of EV LIBs will be eliminated, which was accompanied by the explosive growth of the production of EVs in China. Figure 1 shows the future scrap of ternary batteries (NCM) and lithium iron phosphate batteries (LFP). It is estimated that by 2025, the cumulative scrap of China's electric vehicle batteries will reach 350,000 tons [2].

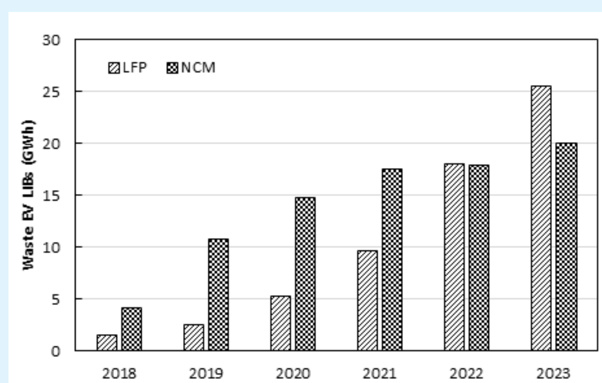

Figure1: Scrap prediction of waste EV LIBs [3].

Although LIBs are green energy batteries, the organic solvents and electrolytes in the electrolyte of waste EV LIBs can cause harm to human skin, respiratory system and eyes. Electrolyte leakage will cause pollution to the environment when the shell of battery is broken. On the other hand, a large number of valuable metals such as nickel, cobalt, manganese, aluminum and copper in waste EV LIBs are non-renewable resources with high economic value. Therefore, recycling of waste EV LIBs by proper methods can not only effectively reduce the regarding pollution, but also can alleviate the shortage of mineral resources and reduce the production cost.

Treatment Strategy and Recycling Market Potential PF Waste EV Libs

Different from LIBs used in small-sized electronic devices such as mobile phones, batteries for EV have extremely high energy, longer cycle life and higher precious metal content [4]. Therefore, recycling of used EV LIBs pays more attention to safety, high material utilization and standardized management. Treatment strategy of waste EV LIBs should include cascading use and recycling, shown in Figure 2. Retired EV LIBs, which cannot be used in EVs due to the reduced battery capacity, will be sent to professional institutions for battery capacity testing. The waste batteries with the residual capacity of more than 80% of the initial capacity are in line with the requirements of electric vehicles, and can be reused in EVs or other low-demand vehicles through relevant in-situ repair and capacity increase technologies. Batteries with a capacity of between 20% and 80% cannot meet the needs of electric vehicles. However, they still have considerable energy storage capacity, which can be reused or cascades in static power supply, extending their life cycle. Waste LIBs with a capacity of less than 20% will be sent to qualified enterprises for dismantling and recycling.

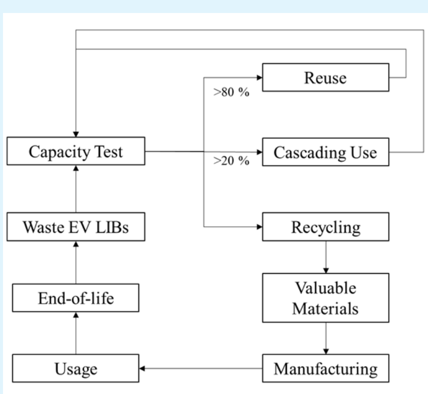

Figure 2: Strategy of EV LIBs Treatment.

The main field of waste EV LIBs cascading use is energy storage [5]. For example, it can be used as a small storage power station to adjust peak and fill valley for the power plant. It can also be used as an energy storage device for renewable energy such as solar energy and wind energy. The use of waste LIBs for energy storage can essentially solve the uneven distribution of energy in time and space. The application of waste EV LIBs in energy storage technology can effectively realize power demand side management, eliminate peak-valley differences, and reduce power supply cost [6,7]. At the same time, it can promote the use of renewable energy, improve the stability of the grid system operation and improve the power quality of the grid and ensure the reliability of power supply. According to estimates [8], the scale of China's power battery cascade utilization will reach 6.4 billion yuan in 2020 and 28.2 billion yuan in 2025.

Waste batteries that do not meet the standards of cascade utilization will be sent to professional battery recycling companies for dismantling and recycling, which will be used for subsequent extraction of high-value heavy metals such as cobalt and nickel, and then reused as raw materials for the production of anode materials. Typical proportion of each material of waste EV LIBs is shown in Table 1.

	Co	Ni	Mn	Li
NCM	2.30%	12.10%	7%	1.90%
LFP	-	-	-	1.10%

Table 1: Typical proportion of each material of waste EV LIBs.
Source: BGRIMM (Beijing general research institute of mining and metallurgy).

The rise in precious metal prices and the scarcity of mineral resources have made recycling of raw materials an important part of the battery market [9]. Waste LIBs can be treated by physical, chemical and biological methods. The physical method mainly includes the crushing flotation, the mechanical grinding and the organic solvent dissolution, the chemical method includes pyrometallurgy and hydrometallurgy, and the biological method is the selective leaching of the metal by the metabolic process of the microorganism. Due to the low energy consumption, high recovery rate and high product purity characteristics, hydrometallurgy is widely recognized and has become the mostly used recovery technology in domestic enterprises.

At present, the EV battery used by electric cars is mainly LFP batteries and lithium ternary polymer batteries. Ternary polymer lithium battery contains higher content of nickel-cobalt metal than the original ore, so its dismantling and recycling has significant economic performance [10,11]. The cost and profit of hydrometallurgical recovery of power batteries are shown in Figure 3. It is estimated that by 2025, China's power battery recycling market will reach 9.7 billion yuan [6].

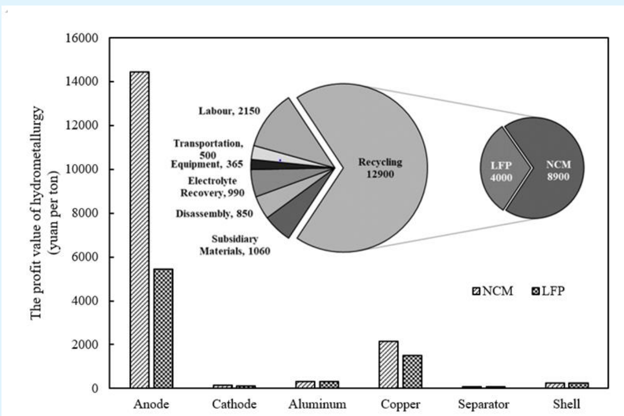

Figure 3: Cost and profit value of hydrometallurgy.

Summary and Recommendations

In view of the threat on environment induced by hazardous materials and valuable components contained in waste LIBs, it has aroused widely attention to treat them by proper methods. Because of high residual energy storage contained in waste EV LIBs, cascading use plays an important role in delaying the decommissioning of EV LIBs and maximizing the use value of them, and is gradually becoming the mainstream trend of recycling and utilization of waste EV LIBs in the future. With the reduction of the cost [12], the cascade utilization will have great development prospects. In addition, a profit of hydrometallurgical recovery of NCM batteries is considerable due to the rapid development of the electric vehicle industry and the increasing shortage of metal resources. As the proportion of ternary materials expands and the prices of valuable metal raw materials increase, waste EV LIBs recycling will have better economic benefit.

From the current situation of EV enterprises and battery manufacturers, which are the main part of waste EV LIBs recycling, the technical standard system of waste LIBs recycling is not perfect. Most enterprises do not have enough accumulated support of relevant technologies, and the cascade technology still needs to be standardized and improved. The research on harmless disposal and recycling remanufacturing technology of waste lithium batteries still needs to be carried out in depth.

Due to the continuous attention of the national government in recent years, relevant policies and regulations are being improved, which leads to a trend of integrated development in the production, cascade utilization, dismantling and recycling of LIBs [13]. The directional flow of waste batteries is basically clear, but has not yet formed a large scale. China's EV battery has not officially entered the peak period of decommissioning, but the problems caused by EV battery cannot be ignored. Efforts should be continued to improve laws and regulations, research and development of advanced technologies, and improve supporting systems, so as to make the EV battery recycling and utilization industry develop healthily towards the trend of process-oriented, specialization and scale.

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