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ANALYSIS OF THE CARBON FOOTPRINT IN THE RECYLING OF TERNARY LITHIUM-ION POWER BATTERIES BASED ON CFB-EV RULES

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Abstract

Lithium-ion power battery is the core component of new energy vehicles. As Chinese electric vehicles being exported to the European Union (EU), the EU has introduced new mandatory regulations and calculation rules for the carbon footprint of power batteries, known as the Carbon Footprint of Electric Vehicle Batteries (CFB-EV) Rules.

Although considerable attention has been paid to the production phase in existing studies, the carbon footprint associated with the recycling phase has not been sufficiently addressed. To address this deficiency, the Life Cycle Assessment (LCA) method, in accordance with the EU's Carbon Footprint of Electric Vehicle Batteries (CFB-EV) rules, is applied in this study to quantify the carbon footprint of the recycling phase of waste ternary lithium-ion power batteries utilized by a certain automobile company in China. A comprehensive evaluation of emissions during the recycling process is thus provided, and key contributors to the carbon footprint are identified, thereby facilitating the enhancement of recycling practices in compliance with regulatory requirements.

The results indicate that under the CFB-EV rules, the carbon footprint to recycle 1 kg of waste ternary lithium-ion power batteries is -0.166 kg CO_2 eq., demonstrating a net reduction in emissions. In the process, valuable raw materials can be recovered, with nickel sulfate, cobalt sulfate, and metallic copper contributing -0.220 kg CO_2 eq., -0.095 kg CO_2 eq., and -0.031 kg CO_2 eq., respectively, to the overall carbon savings. The carbon emissions during the battery recycling process mainly originate from the combined pyrometallurgical and hydrometallurgical treatment of the cells. In the pyrometallurgical process, the primary sources of emissions include the direct release of greenhouse gases, electricity consumption, and natural gas thermal energy usage, with the direct emissions of greenhouse gases being the largest contributor, accounting for 46.25 percent of the total. In the hydrometallurgical process, the emissions mainly result from the use of hydrogen peroxide, sodium hydroxide, sulfuric acid, tap water, and other reagents, with hydrogen peroxide being the largest contributor at 11.65 percent.

These findings suggest that optimizing the cell regeneration stage, particularly by reducing direct emissions and hydrogen peroxide consumption, could enhance the environmental performance of battery recycling and contribute to achieving the dual carbon goals.

Key words: carbon footprint, CFB-EV, emission reduction potential, pyro-and hydrometallurgical combined recycling, waste ternary lithium battery

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