State of the Art Review of Developments in Recycling Technologies of EV Lithium Ion Batteries

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Abstract

The production of electric vehicles is increasing globally with support of local governaments inorder to mitigate the global environmental problems because of the usage of fossil fuels. Increased production of Lithium ion batteries is fast increasing the demand for critical raw materials like Cobalt etc., which reduces the natural resources. Towards the development of sustainable lithium ion battery production industry there is an urgent need to recycle these batteries globally after the end of the useful life of the batteries. The recycling of batteries will reduce consumption of precious energy and avoid or minimize environmental pollution. Most of the spent LIBs will generally end up in landfills instead of recycling because of obvious reasons. Various industrial lithium ion battery recycling processes for the recovery of the all possible contents including primary treatments, secondary treatments, deep recoveries etc., involving pyrometallurgy, hydrometallurgy, direct recovery processes are briefly reviwed. The ability of each technology to recover the substances that can be recovered is discussed. The reusability of the recovered materials in each process, the area of second life applications of LIBs are also presented. It is generally observed that a combination of mechnaical processing with other processes seems ideal for obtaining recycliable materials while highlighting the envimonment friendly green technologies. The importance of battery design for recycling and sustainability including future global promisig technologies such as American Manganese, developmets in Argonne, EU focus on recycling etc., are briefed. Driving the policy makers in favour of recycling due to supply chain concerns is also finally stressed.

A single methodology is hard to be both cost-effective and environmentally friendly due to the complexity of raw materials. A combination of physical and chemical methods is widely adopted to recycle spent LIBs. Physical methods are used to enhance the efficiency of recycling. They include dismantling, crushing, sieving, thermal and mechanochemical treatment. The chemical methods could be classified into pyrometallurgy and hydrometallurgy. Pyrometallurgical processes are usually undertaken at high temperatures. Hydrometallurgical methods have obvious advantages, such as milder reaction conditions, more environmentally friendly, and higher recovery efficiency of valuable metals with the required purities. Hydrometallurgical methods are preferable and promising approaches for processing spent LIBs because of the above advantages.

The demand for the all the four metals is expected to rise drastically currently and near future as the demand and production of LIBs and in effect EVs increase globally. The increasing prices and demand of the metals is driving and motivating the LIB processors towards recycling. Aluminum is used in LIBs substantially in various components.

Although other materials, such as cobalt and nickel are more important for battery recycling from an economic point of view, recycling aluminum has significant CO2 emission reduction potential

Remelting existing aluminum requires just 5% of the energy of new aluminum production, thus yielding significant energy savings and CO2 reductions Improved lithium recycling may reduce the need for lithium mining and the associated water-scarcity risks that lead to social and environmental problems.

According to IEA recycling subsidies and legislation making manufacturers responsible for recycling are likely to continue to be necessary to support a more sustainable supply of battery materials. In a survey of recycling policy in the world's main EV markets, the IEA noted the EU and China have made strides in making battery manufacturers responsible for end-of-use treatment.

By contrast, only three U.S. states – California, New York and Minnesota – currently ban the land filling of lithium-ion batteries and the nation still favors a market-based approach to materials reclamation, rather than making manufacturers bear the burden. India, noted the IEA, has yet to formulate a comprehensive EV and battery recycling policy.

Biography:

Siva was awarded PhD degree in Chemistry from IITM, India in 1979. Having over 40 years global chemical industrial research experience covering wide range of industries specilaing in recycling. Having several proven technologies, publications, and patents with current focus on EV battery development and recycling. Presently working as Independent Consultant to ecofriendly green industries, EV battery industries in India based at Chennai. Conducting workshops on topics including sustainability and waste management.

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