Battery Recycling

Recycling Methods

Pyrometallurgical (LIB)

- Well developed research and most widely implemented method.
- Involves the smelting of materials.
- Highly energy intensive, significant emissions, and used for specific metals.

Hydrometallurgical (LIB)

- Second most commonly used method.
- Involves the mechanical destruction of the battery followed by the chemical precipitation of material.

Direct Recycling (for LIB Reuse/Refurbishment)

- Direct removal of cathode material—maintaining crystal structures.
- Lower emissions and energy requirements.
- Limited by a lack of uniformity in battery designs, requiring significant labor costs.

Lead-Acid Battery Recycling

- Well-developed technology resulting in over 90-percent of batteries being recycled.
- Involves the mechanical destruction and melting.

Risks

Cross-contamination: While the vast majority of lead-acid batteries are recycled profitably, early sorting of battery types is exceedingly important. Between 2010-13 there was a 1000% increase in the number of cases of lithium-ion contamination within lead acid recycling. This can result in fires and explosions at recycling facilities.

Cost, Loss, and Emissions: Significant trade-offs exist between recycling schemes. Independent reports note that reclaiming metals from recycled Lithium-ion batteries, on average, requires more than five times the energy as mining. Furthermore, pyrometallurgical recycling methods (the most prevalent and well-developed of the methods) often result in significant material loss.

As of 2021, more than half of LIBs used in consumer electronics are disposed of in landfills and incinerators.

Role for Standards and Conformity Assessment

Despite early research suggesting reduced emissions and higher efficiency with direct recycling, battery composition and design must be specified and encoded on the batteries to make direct recycling practical. Battery labelling will be increasingly important for sorting prior to recycling as well as to determine the recycled material composition of batteries.

With recycled material content in LIBs (especially cobalt, lithium, and nickel) unlikely to surpass 15-percent of total content demanded within the next decade, enhanced verification and validation processes will be required to ensure closed-loop recycling.