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Hydrometallurgical Recovery of Cobalt, Nickel, Lithium, and Manganese from Spent Lithium-Ion Batteries

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Abstract : Lithium-ion battery (LiB) demand has increased with the advancement in technologies. The applications include electric vehicles, cell phones, laptops, and many more devices. Typical components of the cathodes include lithium, cobalt, nickel, and manganese. Recycling the spent LiBs is necessary to reduce the ecological footprint of their production and use and to have a secondary source of valuable metals. A hydrometallurgical method was investigated for the recovery of cobalt and nickel from LiB cathodes. The cathodes were leached using a chloride solution. Ion exchange was then used to recover the chloro-complexes of the metals. The aim of the research was to determine the efficiency of a chloride leach, as well as ion exchange operating capacities that can be achieved for LiB recycling, and to establish the optimal operating conditions (ideal pH, temperature, leachate and eluant, flowrate, and reagent concentrations) for the recovery of the cathode metals. It was found that the leaching of the cathodes could be hindered by the formation of refractory metal oxides of cathode components. A reducing agent was necessary to improve the leaching rate and efficiency. Leaching was achieved using various chloride-containing solutions. The chloro-complexes were absorbed by the ion exchange resin and eluted to produce concentrated cobalt, nickel, lithium, and manganese streams. Chromatographic separation of these elements was achieved. Further work is currently underway to determine the optimal operating conditions for the recovery by ion exchange.

Keywords : cobalt, ion exchange, leachate formation, lithium-ion batteries, manganese, nickel
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