Improving valuable metal ions capturing from spent Li-ion batteries with novel materials and approaches

ABSTRACT

Rapid growth in the market for batteries is imperative to meet global demand. The lack of economically feasible and environmentally benign recycling process for waste batteries may cause environmental crisis. Taking effective measures could reduce the waste-management challenge and maximize the economic benefits. In this work, environmentally benign citric acid with the presence of reluctant was used to recover cobalt, manganese, nickel and lithium from waste Lithium Nickel Manganese Cobalt oxide (NCM) batteries. Recovery of Co, Mn, Ni, and Li was optimized by varying the citric acid and H2O2 concentrations, the reaction temperature and duration. The recovery of Co, Mn, Ni, and Li were 87%, 90.5%, 93.5% and 96% respectively under the optimum leaching condition of 1.2 mol/L citric acid, 10 vol% H2O2at 95□ for 120 min. Interfacial reaction controlled leaching reaction at low temperature was evident from the results of leaching kinetics with apparent activation energy of 3.75, 10.405.34 and 8.72 kJ mol□ 1 for Co, Mn, Ni and Li, respectively. Importantly, the diffusion controlled leaching reaction was evident from the kinetic and activation energy measurement of leaching. The impact of different chemicals on the environment measured from the Biwer and Heinzle Method (BHM) revealed that the citric acid-assisted leaching process to recover valuable metals from NCM batteries was appeared lower environment impact compare to the other process reported in the literature. The high leaching efficiency and lower impact to the environment provides a novel approach for metal recovery of waste NCM batteries.