

Deep eutectic solvents (DES) assisted recovery of valuable metals from spent LMO cathode materials of Lithium-ion batteries

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Abstract

In the contemporary landscape of lithium-ion battery (LIBs) recycling, a notable paradigm shift is evident, marked by a heightened emphasis on sustainable practices rooted in green chemistry principles. This research investigates the leaching efficiency of deep eutectic solvents (DES) as a novel and environmentally conscious means for the extraction of valuable metals of lithium manganese oxide ($LiMn_2O_4$) from spent LIBs. In this research paper, we introduce a novel approach of recycling lithium manganese oxide from spent LIBs batteries through the utilization of DES which composed of chlorine chloride: lactic acid (ChCl:LA) as leaching agents for the recovery whereby it will be tested against the operating parameters of DES molar ratio, temperature ($^{\circ}C$), solid liquid ratio (S/L), time (hr), presence of reducing agent which is glucose. The spent cathode materials ($LiMn_2O_4$) for the pretreatment process and after leaching experiments are examined using X-ray diffraction (XRD) and scanning electron microscopy (FE-SEM). The leaching efficiencies are investigated through the metal content analysis of both lithium (Li) and manganese (Mn) present in the leachate after the leaching experiment using inductively plasma optical emission spectroscopy (ICP-OES). The outcomes show that the leaching efficiency of both Li and Mn was found to be more than 95% leaching efficiency with operating parameters of DES 1:2 molar ratio, 20g/L of S/L ratio at $90^{\circ}C$ of optimum temperature with ideal reaction time of 1hr. Moreover, the presence of reducing agent, glucose, was also explored where the leaching efficiency reported an increase to about more than 98% for both the valuable metals of lithium (Li) and manganese (Mn) under the condition of DES: glucose molar ratio of (1:2:1) with other optimum parameters keep as constants. The obtained results from this research show that DES mixture of ChCl:Lactic Acid (ChCl:LA) with glucose is able to leached out Li and Mn from the spent lithium-ion batteries.

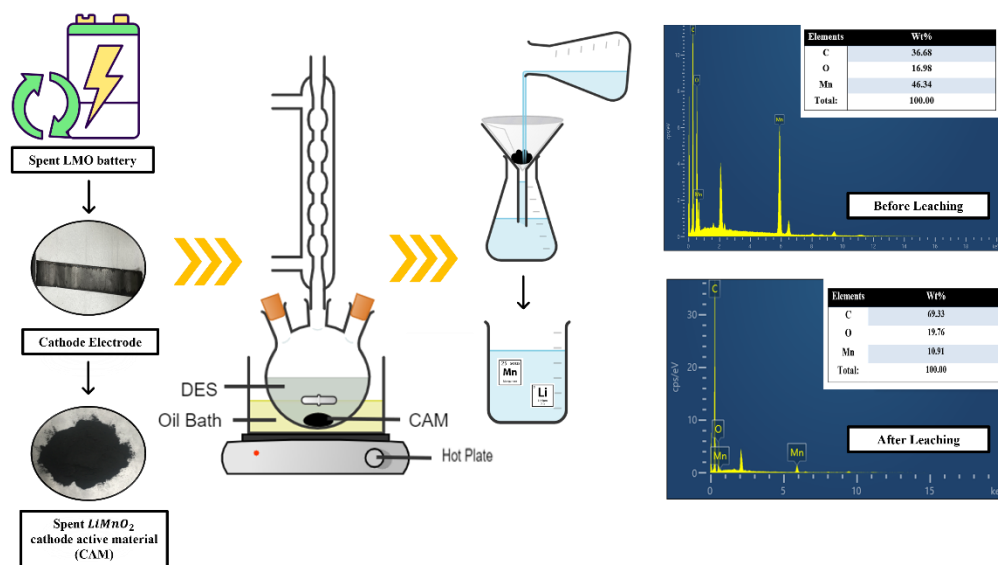


Figure 1: Overall process flow of the leaching experiment with DES