Innovative Ion-Exchange Method for Recycling Used LiFePO4 Battery Cell Cathodes

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Lithium Iron Phosphate (LFP) technology is an emerging Li-ion battery chemistry that is being implemented into mainstream electrical vehicles (EVs) - Ford and Tesla recently incorporated the cathode type - due to its greater sustainability and cost efficacy compared to other Li-ion battery chemistries. However, recycling spent LFP cathodes presents a significant challenge due to their cheap elemental composition, calling for low-cost technology to recover high-value products. In this study, ion exchange (IX) technology was explored to yield Li from LFP material for the first time ever. Two processes were set up to examine a pathway to recycle nearly all components in the LFP cathode: an acid-leaching digestion reaction, and IX chromatography experiments. Oxalic acid was used as a feeding solution in the acid-leaching digestion reaction, while Li-H and Li-K IX reactions using cation IX resins were examined during the IX chromatography experiments. Various trials were run to test the effect of different parameters on the yield of each reaction. For the digestion reaction, the following set of parameters - 0.5 M oxalic acid solution, 25 g/L solid-to-liquid ratio, 80 ºC temperature - produced the greatest Li percent yield at 98.5%. In the IX Chromatography experiments, the K350 resin was deemed superior to the IRC120H (preconditioned with KCl) resin due to its later breakthrough point, indicating greater IX efficiency. The Li-K IX reactions also produce a multi-elemental fertilizer product, which offers a practical recycling strategy for spent LFP batteries. All in all, the results of this study validate the use of IX technology in the recycling of LFP batteries, and as a result, it is pertinent to further investigate the intricacies of the proposed pathway.