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Ultrasound-assisted Leaching of Cobalt and Lithium from Spent Lithium-ion Batteries

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Abstract:

Recovery of cobalt and lithium from spent Li-ion batteries (LIBs) has been studied using ultrasound-assisted leaching. The primary purpose of this work is to investigate the effects of ultrasound on leaching efficiency of cobalt and lithium. The results were compared to conventional leaching. In this study sulfuric acid was used as leaching agent in the presence of hydrogen peroxide. The cathode active materials from spent battery were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM) before and after leaching. Effects of leaching time, leaching temperature, H_2SO_4 concentration, H_2O_2 concentration, solid/liquid ratio, and ultrasonic power have been studied. Optimal leaching efficiency of 94.63% for cobalt, and 98.62% for lithium, respectively, was achieved by using 2M H_2SO_4 with 5% (v/v) H_2O_2 at a solid/liquid ratio of 100 g/L, and an ultrasonic power of 360 W, and the leaching time being 30 min under 30 ℃. Compared with conventional leaching, the ultrasound-assisted leaching gave a higher leaching rate and improved leaching efficiency under the same experimental conditionals. The kinetic analysis of ultrasound-assisted leaching showed that the activation energy of cobalt and lithium were 3.848 KJ/mol and 11.6348 KJ/mol, respectively, indicating that ultrasound-assisted leaching of cobalt and lithium from spent LIBs was controlled by diffusion.

Keywords: ultrasound-assisted leaching, spent lithium-ion batteries, recycling, cobalt

1. Introduction

Lithium-ion batteries (LIBs) have been widely used as electrochemical power sources in mobile phones, laptops, video-cameras and other portable electronics, and recently for electric vehicles (EVs), due to several advantages including high capacity, high energy density, light weight, and good performance [1-3]. The wide application of LIBs results in a rapid increase in the amount

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