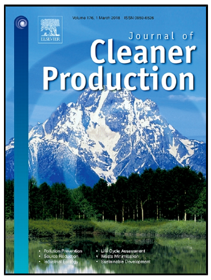
Accepted Manuscript



Use of electrochemical cathode-reduction method for leaching of cobalt from spent lithium-ion batteries

Qi Meng, Yingjie Zhang, Peng Dong

PII:	S0959-6526(18)30115-X
DOI:	10.1016/j.jclepro.2018.01.101
Reference:	JCLP 11781
To appear in:	*Journal of Cleaner Production*
Received Date:	23 June 2017
Revised Date:	08 January 2018
Accepted Date:	13 January 2018

Please cite this article as: Qi Meng, Yingjie Zhang, Peng Dong, Use of electrochemical cathode-reduction method for leaching of cobalt from spent lithium-ion batteries, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2018.01.101

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Use of electrochemical cathode-reduction method for leaching of cobalt from spent lithium-ion batteries

Qi Meng, Yingjie Zhang*, Peng Dong*

National and Local Joint Engineering Laboratory for Lithium-ion Batteries and Materials Preparation Technology, Faculty of Metallurgical and Energy Engineering, Kunming University of Science and Technology, Kunming 650093, China.

Abstract: The present work is focused on the use of electrochemical cathode-reduction method for leaching $LiCoO_2$ produced by spent lithium-ion batteries. The thermodynamics, kinetics, and electrochemical impedance spectroscopy analyses are used to determine the probable control mechanism involved in the leaching of cobalt from spent $LiCoO_2$. The leaching efficiencies reached about 90% for cobalt and nearly 94% for lithium using 1.25 mol/L of malic acid and a working voltage of 8 V for 180 min at 70 °C. Kinetics analysis indicates that the leaching process of cobalt could be divided into two stages: the first stage is controlled by a surface chemical reaction, and the second stage is controlled by a combination of the surface chemical reaction and diffusion. Electrochemical impedance spectroscopy, X-ray photoelectron spectroscopy, and transmission electron microscopy analysis show that the combination control at the second stage is related to the form of $Co(OH)_3$ produced during the leaching process of spent $LiCoO_2$. Finally, a novel process for the leaching of cobalt from spent $LiCoO_2$ is proposed.

Keywords: spent lithium-ion batteries; leaching; electrochemical cathode reduction; kinetics; EIS

1. Introduction

The manufacture of lithium-ion batteries (LIBs) is increasing to meet the global demand for power sources required for portable electronic devices, electric vehicles, and other such applications because of their favourable features such as their high-energy density, high cell voltage, modest size and low self-discharge (He et al., 2017b; Horeh et al., 2017). However, this has led to the release of large quantities of spent LIBs (Yang et al., 2017). These spent LIBs should not be disposed into landfills because they contain heavy metals and organic electrolytes such as $LiPF_6$, which are potential hazards to the ecosystem and human health (Xin et al., 2015; Pant et al., 2017). At the same time, spent LIBs have been identified as attractive secondary sources of valuable metals owing to the limited amount of natural reserves and their ever-increasing demands (**Fig. 1**) (Xiao et al., 2017). Hence, reasonable management and recycling of spent LIBs using suitable methods should be developed that could benefit both the global environment and economy.

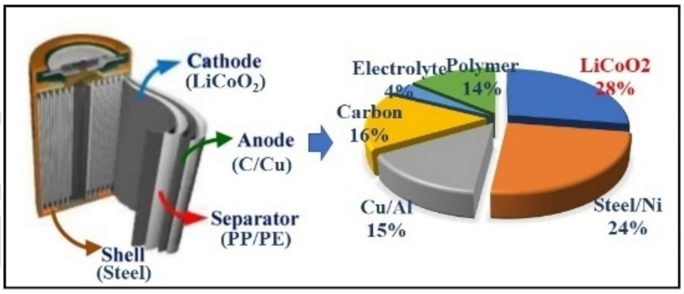


Fig. 1. Components of a typical lithium-ion battery.

$LiCoO_2$ is the first commercialized cathode material type, and it is widely employed in most commercial LIBs that power consumer electronics devices. Therefore, it is regularly discarded in large quantities, and this quantity is expected to increase further in the coming years. Spent $LiCoO_2$ batteries contain significant quantities of cobalt and lithium (**Fig. 1**), which have a high economic value (Bertuol et al., 2016). Therefore, many studies have investigated on developing methods to recover cobalt and lithium from spent $LiCoO_2$ batteries (Gu et al., 2017). The recycling technologies of spent $LiCoO_2$ batteries can be categorized in two: the hydrometallurgy method and the

Download English Version:

https://daneshyari.com/en/article/8097841

Download Persian Version:

https://daneshyari.com/article/8097841

Daneshyari.com