Chemical Engineering Journal 215–216 (2013) 162–167

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Toward greener comprehensive utilization of bastnaesite: Simultaneous recovery of cerium, fluorine, and thorium from bastnaesite leach liquor using HEH(EHP)

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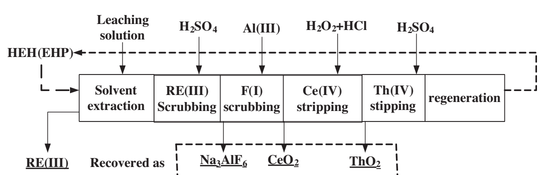
HIGHLIGHTS

- ▶ A novel process was developed to simultaneously recover Ce(IV), F(I) and Th(IV) from bastnaesite.
- ▶ HEH(EHP) was used alone to separate RE(III), Ce(IV), Th(IV), and F(I).
- ▶ Extraction efficiency for the elements is in order of Ce(IV) > F(I) > Th(IV) ≫ Ce(III).
- ▶ Reductive stripping of Ce(IV) from the loaded organic with H_2O_2 and HCl.
- ▶ Appropriate technical parameters for industrial application were provided.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 2 July 2012
Received in revised form 28 September 2012
Accepted 28 September 2012
Available online 12 November 2012

Keywords:
Cleaner production
Coordination scrubbing
Reductive stripping
Bastnaesite
HEH(EHP)

ABSTRACT

This paper describes a novel process for conducting the extraction and recovery of cerium, fluorine, and thorium from a bastnaesite sulfuric leaching solution using HEH(EHP) (2-ethylhexylphosphonic mono-2-ethylhexyl ester) as the solvent, and investigates the effects of HEH(EHP) concentration, the stoichiometric quantity of H_2O_2, and H_2SO_4 concentration in the Th(IV) stripping liquor on extraction quantity and purity. Analysis of the process shows that Ce(III) extraction capacity with HEH(EHP) is negligible, and extraction efficiency for the elements is in order of Ce(IV) > F(I) > Th(IV) ≫ Ce(III). After coordination scrubbing of F(I) with Al(III), Ce(IV) is reductively stripped with H_2O_2 and HCl, allowing recovery of CeO_2 with a purity of 99.95%. Furthermore, this paper provides appropriate technical parameters for industrial application of the extraction system—confirmed by a multistage countercurrent extraction test—showing that this process provides a more environmentally sound integrated separation and recovery flow of rare earths from bastnaesite.

1. Introduction

Resource management and environmental care are the basis of sustainable development for human society. Due to their unique magnetic, optical, and electrical properties, rare earths are an important and widely strategic resource used in high-tech fields [1–5]. China has abundant rare earth resources, providing over 95% of the world's output of rare earth with its products and exports [6]. Bastnaesite is the main type of rare earth mining in Sichuan, China. Output from bastnaesite typically contains 0.2–0.3 wt% thorium and 8–10 wt% fluorine in addition to the rare earth, of which about 50 wt% is cerium [7,8]. Exploitation of bastnaesite started in China in the early 1980s [9]. At present, industrial bastnaesite processing usually involves oxidation roasting, hydrochloric acid leaching, and solvent extraction, as shown in Fig. 1. The traditional hydrometallurgical process for rare earths in industry

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http://dx.doi.org/10.1016/j.cej.2012.09.126