Chemical Engineering Journal 218 (2013) 303–308

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Recovery of metallic palladium from hydrochloric acid solutions by a combined method of adsorption and incineration

Sung Wook Won [a], Yeoung-Sang Yun [a,b,*]

[a] Department of BIN Fusion Technology, Chonbuk National University, Jeonbuk 561-756, Republic of Korea
[b] School of Chemical Engineering, Chonbuk National University, Jeonbuk 561-756, Republic of Korea

HIGHLIGHTS

- The maximum uptake of Pd(II) by TP 214 was 241.1 mg/g.
- A metallic Pd was recovered through the combined method of adsorption and incineration.
- Incineration temperature and Pd content affected the recovery efficiency and purity.

ARTICLE INFO

Article history:
Received 9 October 2012
Received in revised form 14 December 2012
Accepted 17 December 2012
Available online 29 December 2012

Keywords:
Lewatit MonoPlus TP 214
Ion exchange resin
Adsorption
Incineration
Metallic palladium

ABSTRACT

This study evaluated the recovery of palladium (Pd) by ion exchange resins from hydrochloric acid solutions using a combined method of adsorption and incineration. Lewatit MonoPlus TP 214 was selected as a representative commercial ion exchange resin and its adsorption performance was evaluated. Kinetic and isotherm experiments revealed that Pd(II) adsorption equilibrium was reached within 21 h, and the maximum uptake estimated by the Langmuir model was 241.1 ± 11.6 mg/g. To recover Pd as a solid form, the Pd ions-loaded resin was incinerated. The effects of incineration temperature and Pd amount were examined to enhance the recovery efficiency and purity of the recovered Pd. SEM–EDX and XRD analyses were used to confirm existence of Pd phase in ash incinerated in air at 600 °C and 900 °C. Both the incineration temperature and Pd amount significantly affected the recovery efficiency and purity. The form of Pd was changed from PdO to Pd^0 as the incineration temperature was increased from 600 °C to 900 °C. At 900 °C and 258.5 mg/g of Pd(II) uptake, metallic Pd was successfully recovered with 99.0% of recovery efficiency and 96.1% of purity. Consequently, it can be claimed that the sorption–incineration process is likely an effective way enabling simple and fast recovery of precious metals as a metallic form from waste solutions.

1. Introduction

Precious metals, especially platinum group metals (PGMs) such as ruthenium (Ru), rhodium (Rh), palladium (Pd), osmium (Os), iridium (Ir), and platinum (Pt), are of great significance in various industries due to their specific physical and chemical properties. They are widely used in many fields, such as catalysts in various chemical processes, electrical and electronic componentry, medicine, and jewelry. As a result, the demand and commercial value of PGMs are steadily increasing, but as natural resources, they are limited all over the world and are becoming depleted [1–3]. Therefore, the recovery of PGMs from primary sources (minerals) and secondary sources (PGM-containing waste solutions) is of great economic interest, and the recovery techniques are becoming more important [4].

Processes for the recovery of PGMs from various wastes include hydrometallurgical and pyrometallurgical processes. The hydrometallurgical processes have been used successfully for the recovery of PGMs, and they have been used more frequently than the pyrometallurgical processes. The hydrometallurgical methods include solvent extraction, precipitation, adsorption and ion exchange to separate and recover PGMs in high-level liquid waste [5]. Moreover, platinum and palladium in spent petroleum catalysts can be recovered through various hydrometallurgical methods. Among these methods, the adsorption of noble metals by ion exchange resins is one of the most promising methods for the recovery of PGMs from aqueous solutions. This is due to the high efficiency and selectivity of ion exchange resins towards PGMs [6]. However, ion exchange resins are rarely used for

* Corresponding author at: Department of BIN Fusion Technology, Chonbuk National University, Jeonbuk 561-756, Republic of Korea. Tel.: +82 63 270 2308; fax: +82 63 270 2306.
E-mail address: ysyun@jbnu.ac.kr (Y.-S. Yun).

1385-8947/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2012.12.052