

Thermal-Assisted Solvent Extraction of Inert Platinum Group Metals from $\text{HNO}_3(\text{aq})$ to Ordinary Organic Solvent

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Abstract

Separation of platinum group metals (PGMs) is relevant to treatment in high level wastes. However, some PGMs are so inert that their extraction is not always efficient. In this study, we investigated how to accelerate solvent extraction of inert PGMs under temperature controlled condition. Herein, we employed a pyridine diamide as an extractant.

Keywords: Solvent Extraction, Platinum Group Metals, Thermal-Assisted, Ordinary Organic Solvent

1. Introduction

High level waste (HLW) always contain some platinum group metals (PGMs) like Pd, Rh, and Ru. These PGMs would make serious problems in vitrification of HLW. Therefore, it is important to separate PGMs from HLW in advance, while it is sometimes disturbed by chemical inertness of Ru(III) and Rh(III). Heating is effective and popular to enhance a reaction rate. Indeed, we have succeeded in rapid and efficient extraction of Ru(III) and Rh(III) in $\text{HNO}_3(\text{aq})/[\text{Hbet}][\text{Tf}_2\text{N}]$ systems under microwave or convection heating [1][2]. However, this extraction system is rather exotic, and not very familiar with industrial applications because of ionic liquid. In this study, we tried to expand this technique to more practical extraction systems of ordinary organic solvents like 1-octanol. Here, a pyridinediamide, TBPDA, shown in Fig. 1 was employed as an extractant for Ru(III).

2. Experimental

The pre-equilibrated $\text{HNO}_3(\text{aq})$ with Ru(III) was loaded into a screw cap vial, and mixed with pre-equilibrated 1-octanol dissolving TBPDA (30mM) in 1:1(v/v) ratio. This mixture was agitated on a thermostat stirrer. The Ru(III) concentration in aqueous layer was determined by ICP-AES.

3. Results and Discussion

Fig. 2(a) shows Ru(III) extraction behavior at 298 K and 356 K in 0.5 M $\text{HNO}_3(\text{aq})/1\text{-octanol}$ biphasic system. As a result, extraction kinetics has been accelerated with elevating temperature. However, extractability has reached 29% even at 356 K, which is still not high enough. To improve this situation, we tested effect of Tf_2N^- as an additional hydrophobic anion to promote formation of extractable ion pair of $[\text{Ru}(\text{NO})(\text{TBPDA})]^{3+}$. With increasing $[\text{Tf}_2\text{N}^-]$, extractability of Ru(III) at 356 K actually increased as expected (Fig. 2(b)). In this study, we found Ru(III) can be extracted to 1-octanol rapidly with elevating temperature and efficiently under assistance of additional Tf_2N^- .

References.

- [1] Ikeda, S.; Mori, T.; Ikeda, Y.; Takao, K. *ACS Sustainable Chem. Eng.* **2016**, *4*, 2459-2463.
- [2] Kono, S.; Kazama, H.; Mori, T.; Arai, T.; Takao, K. *ACS Sustainable Chem. Eng.* **2018**, *6*, 1555-1559.

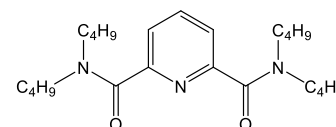


Fig. 1. Schematic structure of TBPDA.

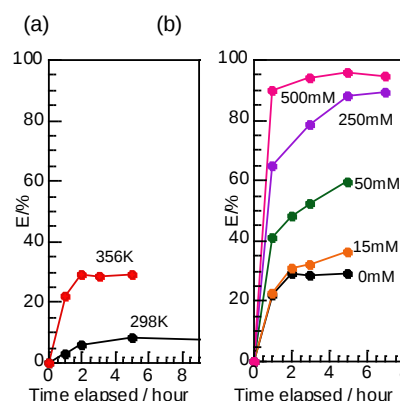


Fig. 2. Progress of Ru(III) extraction at different temperatures (a) and concentrations of additional Tf_2N^- at 356 K (b).