Selective Extraction of Soft Metal Ions in Nitric Acid Solution by a New Ionic Liquid including TPEN Structure

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Abstract

A novel hydrophobic ionic liquid including TPEN structure ($(IL\text{-}TPEN)^+NTf_2^-$) was successfully synthesized and its extraction behavior of Cd^{2+} and Zn^{2+} from nitric acid solution was investigated. The maximum separation factor of Cd^{2+} and Zn^{2+} was obtained as 8 at pH 2.

Keywords: hydrophobic, ionic liquid, TEPN structure, Cd^{2+}

1. Introduction

TPEN (*N,N,N',N'*-tetrakis(2-pyridylmethyl)ethylenediamine) as a kind of podand-type molecule has six nitrogen donor sites which can form complexes with various metals, such as cadmium, copper, lanthanides, actinides and so on. However, there are several properties of TPEN that should be improved for its widespread application. A major drawback of TPEN has been water solubility in acid condition. On the other hand, ionic liquids (ILs) possesses many unique properties and its physicochemical properties such as water immiscibility is able to effectively be tuned, depending on the structure of cations and anions. Accordingly, combination of hydrophobic ionic liquid substituents including TPEN derivatives is intriguing to develop a practical extraction system of metal ions in nitric acid solution. Herein, we reported extraction performance of Cd^{2+} and Zn^{2+} from nitric acid solution by using a novel hydrophobic ionic liquid including TPEN structure($(IL\text{-}TPEN)^+NTf_2^-$).

2. Experimental and Conclusion

The results of extraction experiment of Cd^{2+} and Zn^{2+} on the variation of pH value were summarized in Figure 1. $(IL\text{-}TPEN)^+NTf_2^-$ (1mM) dissolved in $(C_6mim)^+NTf_2^-$ (V_{IL}= 1.5mL) was observed to show high extractability and significant selectivity of Cd^{2+} (0.5mM) and Zn^{2+} (0.5mM) in the pH range from 1 to 5 (V_{aq}= 1.5mL). For instance, more than 50% of Cd^{2+} was extracted from aqueous phase into ionic liquid phase when the pH≥ 1. However, the amount of Zn^{2+} extracted was less than 20%. And the maximum separation factor can be obtained as 8 at pH 2. At the same time, the extractability of both Cd^{2+} and Zn^{2+} were reduced rapidly by decreasing pH, and almost no extraction was observed when the pH< 1. It could be explained as the pyridyl groups on the TPEN structure was easily protonated to lose its coordination ability under highly acidic condition. In conclusion, the improvement of hydrophobicity of TPEN by introducing hydrophobic ionic liquid substituent was proved to be feasible and effective.

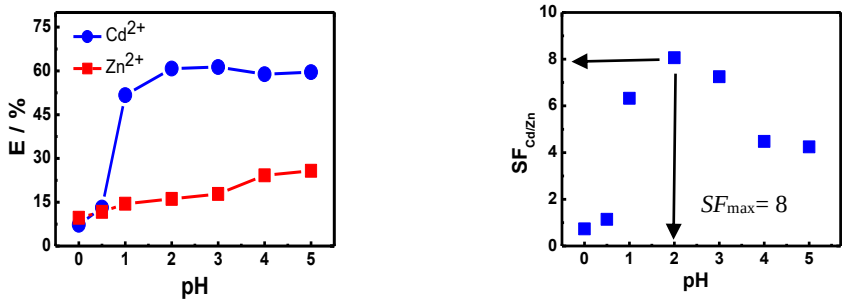

Figure 1: the plot of extractability(*E*), separation factor(*SF*) of Cd^{2+} and Zn^{2+}

References

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