Characteristics of the Precipitate From Cs^+ Extraction Using Ionic Liquids

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1. Introduction

The chemical and physical properties of precipitates from Cs^+ extraction process using ionic liquids (ILs) [1] were investigated. The chemical form was Cs^+•Tf_2N^-•DCH18C6 which is a Cs ionic solid extracted by the extractant of DCH18C6. The solid liquid separability of the precipitates were also studied by using the physical properties including density and thermal stability.

2. Experimental

2.1 Materials

Cesium nitrate ($CsNO_3$, 99%) and the extractant, dicyclohexano-18-crown-6 (DCH18C6, 98%) were purchased from Sigma-Aldrich Chemical Co. (Germany). The ionic liquids, 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (C_2mimTf_2N) was purchased from C-TRI Co. Ltd. (Korea).

2.2 Method

CsNO3 simulated waste solution was prepared at 30 mM concentration. And then 0.6 mM DCH18C6 was dissolved in 0.6 mmol C_2mimTf_2N. These aqueous phase and organic phase was mixed for 2 hours at 25°C. After extraction, the precipitate was separated. To get the dried precipitate, the precipitated was placed in the oven at 80℃. The precipitate was analyzed by SEM, PSA, TGA, DSC and XRD.

3. Results

We found that the new phenomenon, the precipitate is formed when the amount of ILs was reduced [1]. We confirm that the precipitate consist of Cs+•Tf2N-•DCH18C6 by SEM-EDS as shown in Fig. 1(c).

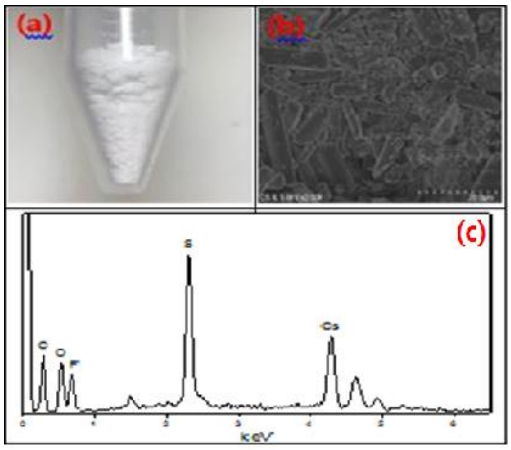

Fig. 1. Experimental image (a), FE-SEM image (b), SEM-EDS spectrum (c) of the precipitate.

From now on, it is the result of sediment size analysis and thermal analysis to judge whether the solid-liquid separation of cesium is applicable.

3.1 Size distribution of the precipitate

The particle size of the precipitate was analyzed to be 171.7 um on average and most of the precipitates were evenly distributed between 100 and 400 um. Even, small particles are of a size (over 10 μm) enough to separate with conventional MF filter.

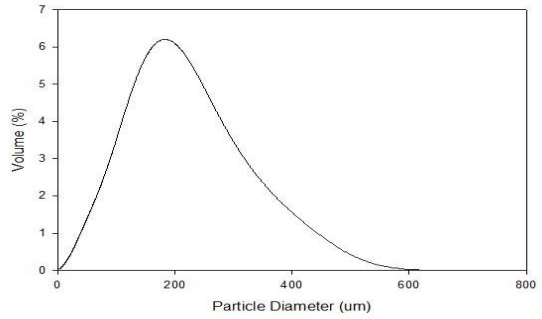

Fig. 2. PSA result of the solid precipitate.

3.2 Physical properties depending on temperature

These graphs indicate that the melting point and weight loss of the precipitate respectively. The precipitate was dissolved at 91.1℃, it takes 28.20 W/g (Fig. 4). The precipitate is stable up to 300°C.

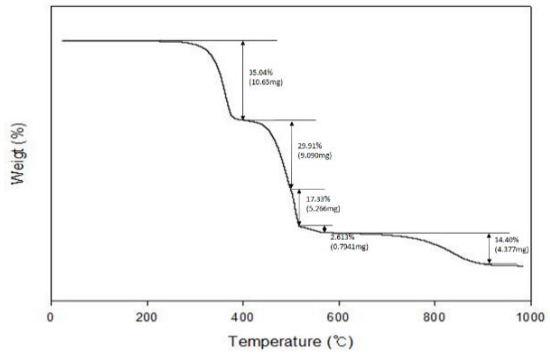

Fig. 3. TGA curves of the solid precipitate.

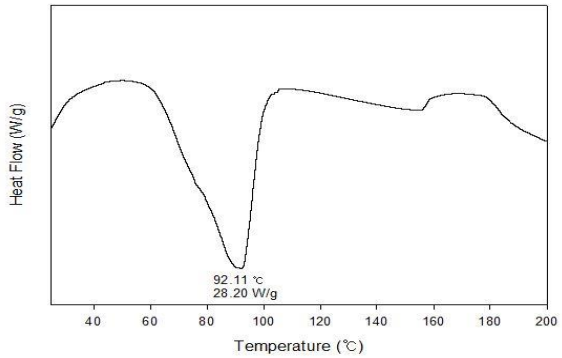

Fig. 4. DSC curves of the solid precipitate.

The XRD results of the precipitate showed numerous sharp peaks, indicating that the precipitate was crystalline ordered structure.

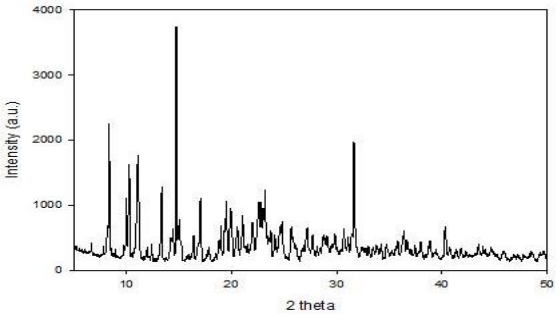

Fig. 5. XRD result of the solid precipitate.

4. Conclusion

Through the studies on the precipitates from Cs^+ extraction process using ionic liquids (ILs), the following conclusions were obtained within the experimental ranges.

1) By analyzing the size of the precipitate, it was confirmed that it is easy to separate from the waste solution in the actual process. Also, the density of precipitate has 1.315 g/cm^3 value.
2) Through analysis, it was confirmed that the thermal stability of precipitate was not degraded up to 300°C. The precipitate was melted at 91.1°C, and the precipitate had a crystalline structure.

ACKNOWLEDGEMENT

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REFERENCES

[1] K. Sumin et al., “A novel method for separating Cs+ from liquid radioactive waste using ionic liquids and a selective extractant”, J Radioanal Nucl Chem 311:1605–1611 (2017).