Extraction of Actinides from Nitric Acid Solutions by Using N,N-di(2-ethylhexyl)-diglycolamic Acid

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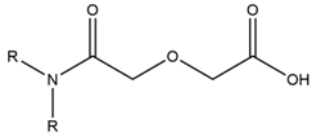
INTRODUCTION

N,N-di-alkyl-diglycolamic acids have been investigated as extractants for the separation of lanthanides and actinides from aqueous solutions of pH region through high acid concentration.[1, 2] For instance, N,N-di(2-ethylhexyl)-diglycolamic acid (DEHDGA) acts mainly as common carboxylic acid to extract actinides and lanthanides from the solutions with acid concentration lower than 1 M HNO_3 by ion exchange mechanism. During the extraction, cationic metal ions are extracted into the organic phase and equivalent H^+ are exchanged into aqueous phase. In contrast, DEHDGA behaves as neutral ligands to catch the metal ions from the solutions of high acid concentration. During the extraction, nitrate is extracted together with the metal ions into the organic phase as counterions to balance the electronic charge.

In our previous study, it was found that DEHDGA has good capability to extract actinide and lanthanide ions from nitric acid solutions of high concentration. In the extraction, the acidic extractant molecules bond to metal ions as neutral ligand and probably link to counterion nitrate through hydrogen bond. This arrangement results in charge-neutral liposoluble species instead of positive charged species, preventing from easily forming third phase. The good extraction capability and loading capacity to lanthanide and actinide ions make the DEHDGA-kerosene system very promising for advanced nuclear fuel reprocessing. Here, the extraction of U(VI) from high nitric acid solutions was conducted by only using DEHDGA as extractant (Scheme I). The extracted complex of U(VI) in the organic phase was investigated by UV-Vis spectroscopy and by measuring the dependency of the extraction on the ligand concentration.



N,N-di(2-ethylhexyl)-diglycolamic acid
(HDEHDGA, HA), R = 2-ethylhexyl

Scheme I Structures of the related ligands

RESULTS

As shown in Figure 1, with the increasing concentration of DEHDGA in the organic phase, the absorption of the extracted U(VI) complex increase but the pattern of the spectra does not change, suggesting there is only one complex species formed in the organic phase.

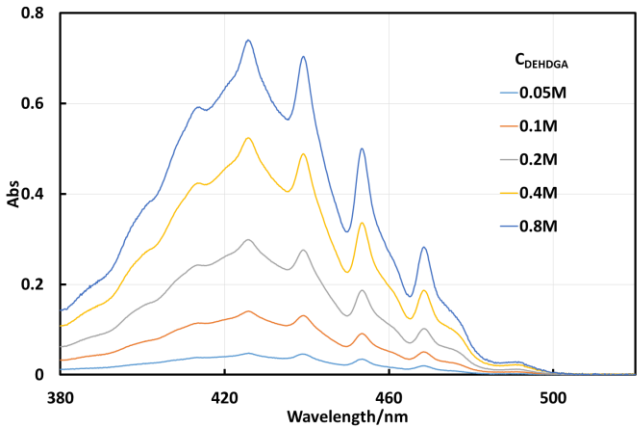


Fig. 1. The absorption spectra of the extracted U(VI) complex with DEHDGA. Initial aqueous solution: 0.05 M U(VI) in 4 MHNO_3.

Not surprisingly, the slope of the linear plot from $\log D_U$ against $\log C_{DEHDGA}$ is 1.66, close to 2, suggesting that two ligand molecules bond to U(VI) in the extracted complex.

CONCLUSION

In summary, an organic acidic extractant, HDEHDGA, was found to have good capability to extract actinide and lanthanide ions from nitric acid solutions of high concentration. In the extraction, the acidic extractant molecules might bond to metal ions as neutral ligand and link to counterion nitrate by hydrogen bond, resulting in charge-neutral liposoluble species preventing from forming third phase. For uranyl(VI) ion, with loading U about 100 g/L there is no third phase formed in the organic phase of 1.0 M HDEHDGA in kerosene. The good extraction capability and loading capacity to lanthanide and actinide ions make the HDEHDGA-kerosene system very promising for advanced nuclear fuel reprocessing

REFERENCES

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