Aqueous Extraction of Rare Earths from Nitric Acid Solution

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Introduction:

Overview

- Aqueous extraction takes the desired metal ions while leaving unwanted ions
- Two phases: organic and aqueous
- Pregnant leach solution: aqueous phase

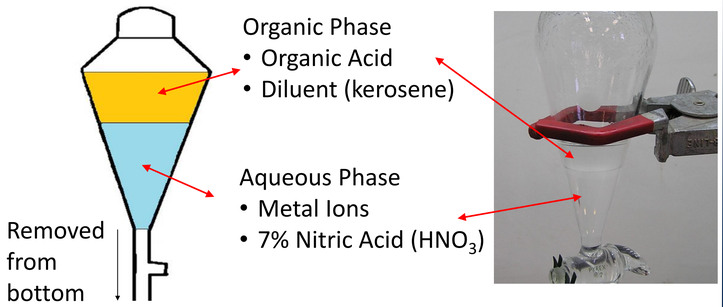

Figure 1
Experiment that is complete and is ready for the removal of aqueous phase for analysis

Broader Impact

- China is the top producer rare earth elements
- Rare earths are used in many critical applications important not only to the U.S. economy but also has many crucial uses in the U.S. military
- U.S. has very few mines that are producing these elements

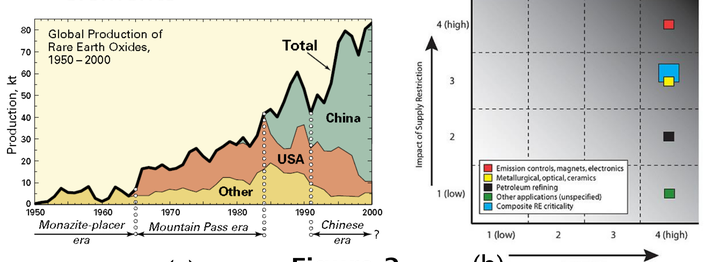

Figure 2
(a) world production of rare earth oxides (b) supply risk vs. impact of supply restriction

Atomic Absorption Spectroscopy (AAS)

- Machine used for analysis of aqueous solution
- Detects absorption of elements from flame
- Uses calibration curve to determine concentration of solution

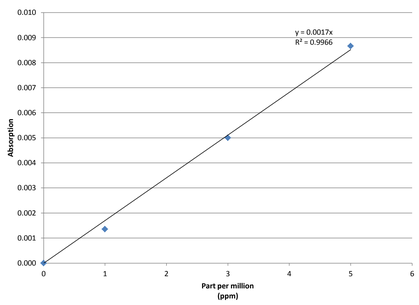

Figure 5
Calibration curve used to interpret the absorption the machine reads

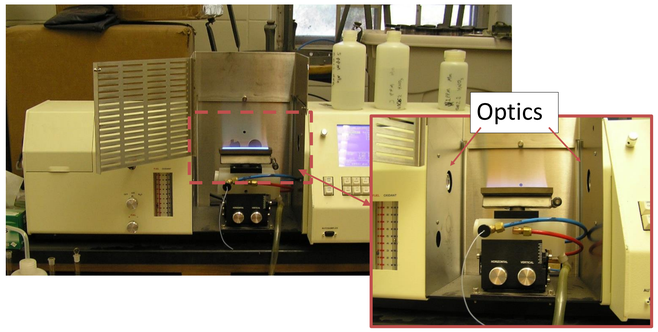

Figure 6
Atomic Absorption Spectroscopy (AAS)

Results:

Single Ion Solutions

Both of the figures shown below are isotherms of two different elements at specific concentrations and temperature with differing starting pHs. They show the optimal pH range where these different elements can be extracted by themselves.

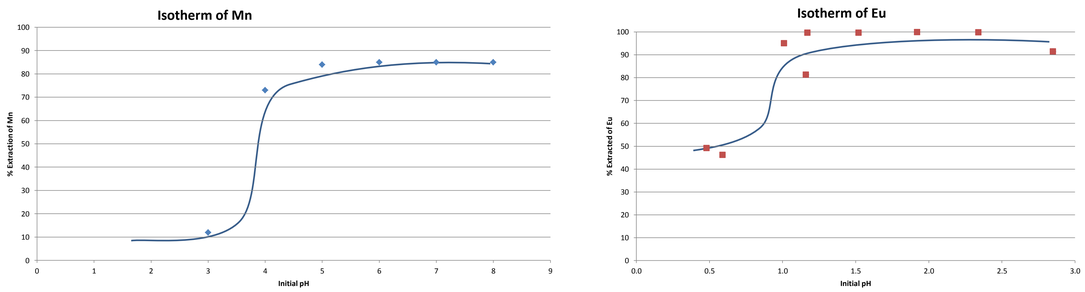

Figure 4
Shown above in both images are single ion solutions that were started at different pHs and ran until equilibrium. The experiments and construction of image on the left were done by Kelsey Fitzgerald.

Procedure:

- Equal one-to-one volumetric ratio of aqueous to organic solutions (10mL)
- Both phases are hand shaken for ten minutes done in two-minute intervals
- After mixture is complete, solution is allowed to sit for twenty minutes
- Aqueous phase is removed from the bottom for analysis

$$3(\mathrm{HA})_{2\,(org)} + RE^{+3}_{(aq)} \leftrightarrow 3H^{+}_{(aq)} + \mathrm{REA}_2 * 3\mathrm{HA}_{(org)}$$

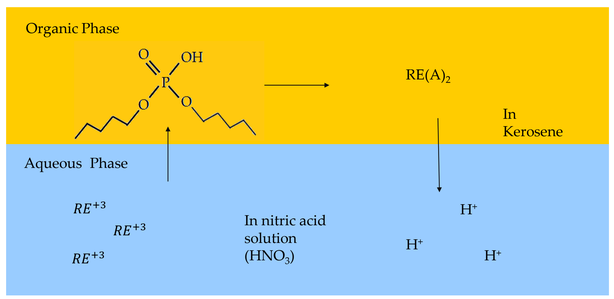

Figure 3
During the mixing process, this is the proposed mechanism for the extraction.

Conclusion:

Summary

- pH does affect the extraction of rare earths
- Best extraction of europium is from 1.5 to 2.5 pH

Future Work

- Add more metal ions to the aqueous phase to simulate a more realistic leach solution
- Kinetic experiments with rare earth elements

Acknowledgments:

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