K_D STUDIES OF CU & ZN SEPARATIONS FOR RADIOISOTOPE PRODUCTION APPLICATIONS

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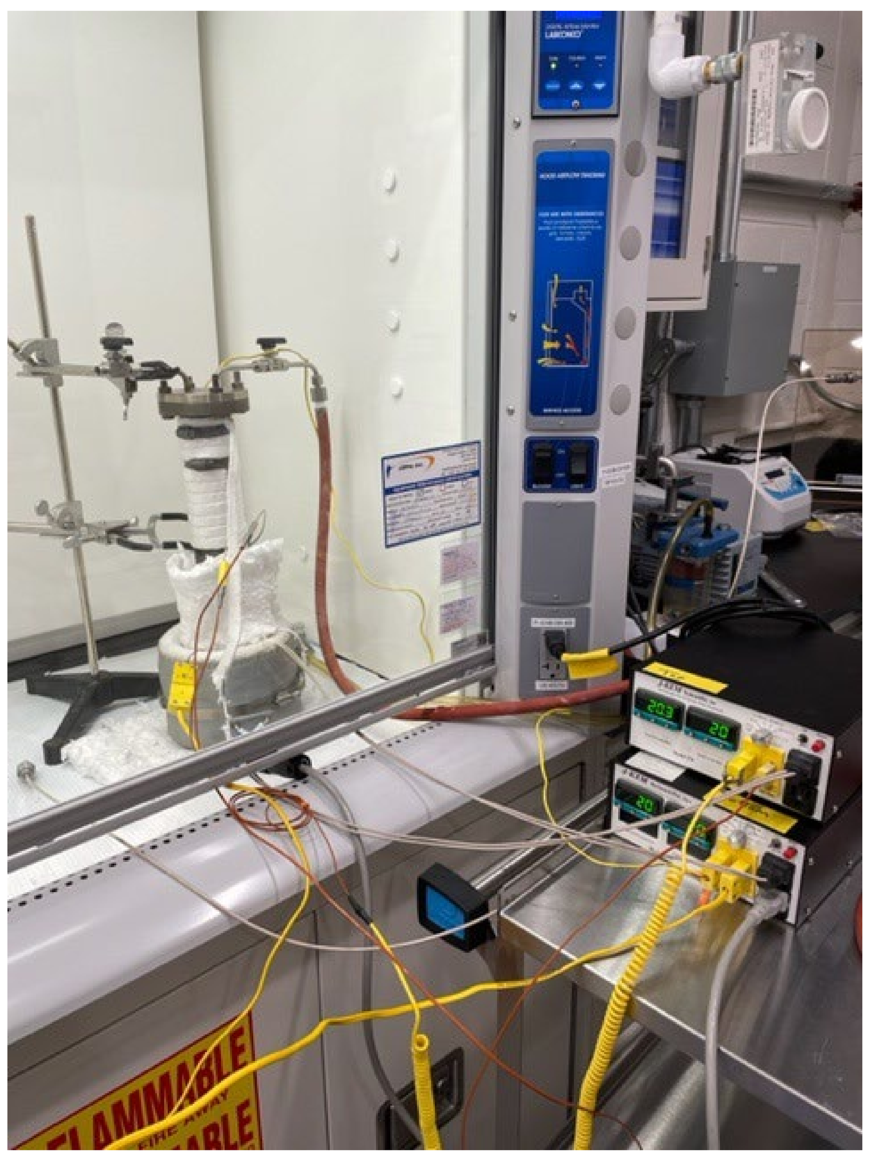
INTRODUCTION

Radionuclide therapy has been drastically expanding in the medical field due to its ability to target tumors in cancer patients. Cu-67, a radioisotope used in these treatments is linked to a targeting vector and injected into the blood stream which then accumulates at cancer sites without causing harm to healthy tissues and organs in a patient. For this treatment to be effective the radioisotope must be purified for it to be used in this manner. The purification process for the Cu-67 produced at Argonne National Laboratory involves separating the radioactive copper product from the zinc target material through a two-step process. The first step utilizes a vacuum sublimation to remove the bulk of the zinc while the second step relies on a column separation with anion exchange resin. The K_D and vacuum sublimation studies performed in this work helps identify which conditions are optimal for the separation of copper and zinc. These studies were tested without radiation due to lower expense and safety concerns.



The initial bulk separation of the zinc and copper is performed in the sublimation system(left). The zinc is collected in an alumina tube while the copper product remains in the target crucible(above).

What are the optimal conditions to separate copper from zinc? A previous study provided a strong foundation for separating copper and zinc mixed materials.[1] The article concluded that a longer heating time with a strong vacuum would be an efficient means of separation though they still achieved separation of the material using a shorter time (120 min.) and a high temperature (850 °C). In contrast, our experiment used a time of 300 min., a temperature of 625 °C and pressure of 200 mtorr. A comparison of the results from both experiments was performed. The K_D studies undertaken were derived from studies which showed metals fractionate in acid when an acetate buffer is used.[2] In turn we mixed anion exchange resin with copper and zinc solutions to determine the separation efficiencies.

EXPERIMENTAL PROCEDURE

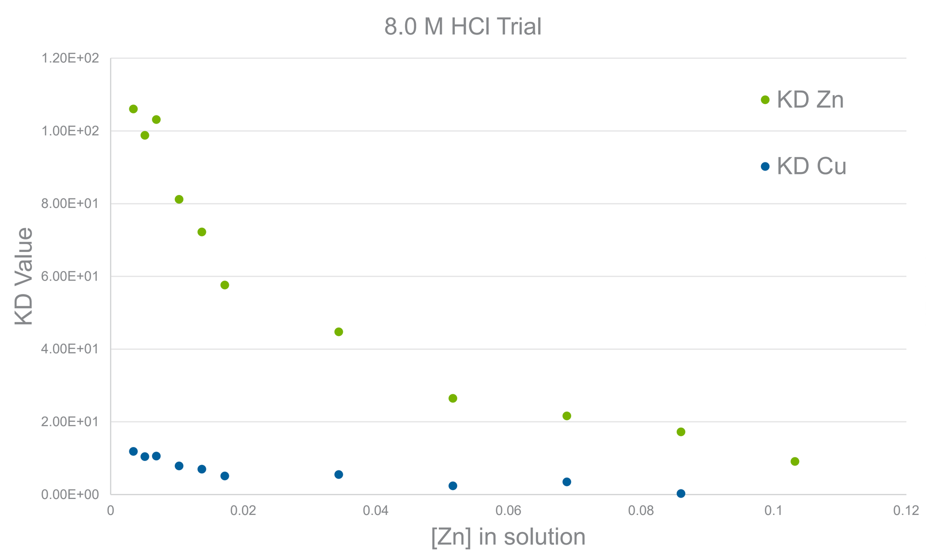
- **Preparation**
  - Hydrochloric acid solutions of 0.1, 2.5, and 8.0 M were prepared.
  - The desired amount of resin was weighed into each vial.
  - The vials were filled to 3mL with the desired HCl solution.
- **Inversion Processes**
  - The vials were inverted for at least 24 hours for equilibration.
  - The vials were then centrifuged at 3,000 rpm for 10 min. then the supernatant was decanted.
  - Desired amounts of copper and zinc were added to the vials and filled with HCl solution to 10 mL.
  - The vials were inverted for another 24 hours to allow contact with the resin.
  - They were again centrifuged and sampled into fresh vials for analysis.
- **Analysis process**
  - The copper and zinc concentrations were analyzed by inductively coupled plasma mass spectrometer (ICPMS).
  - Results were calculated using the K_D equation (C0/Cf -1) x (mL/g).

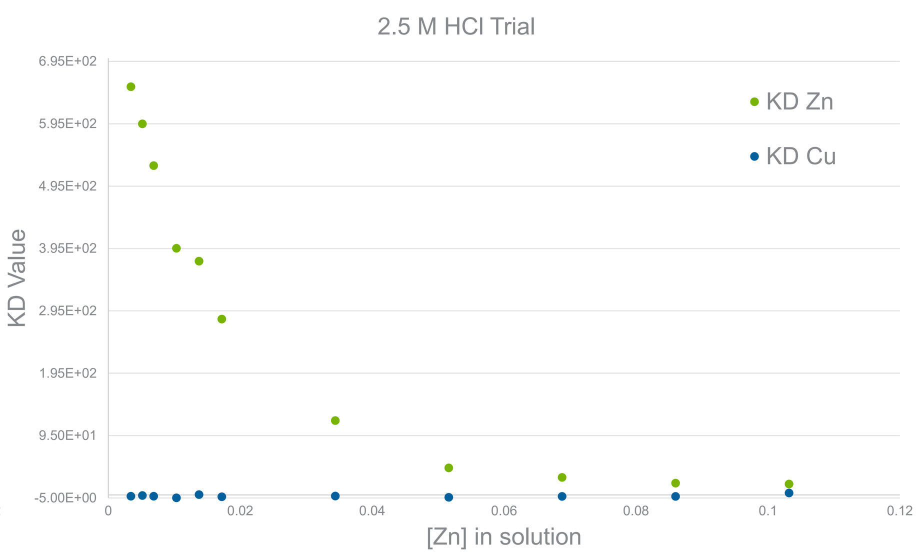
RESULTS & DISCUSSION

The metal ions were pipetted into centrifuge vials using a sample matrix to test various concentrations of zinc with a fixed concentration of copper with 2.5 M and 8.0 M HCl (right).

The vials were agitated overnight using a rotating mixer to allow sufficient equilibration of the metal ions with the resin (left).

The samples were centrifuged down to concentrate the resin in the bottom of the vials and the supernatant was sampled (right).





- The graphs above (8.0 M and 2.5 M) indicate the Zn and Cu can be successfully separated with the Amberchrome AG-1x8 resin. The copper and zinc show a high affinity to the anion exchange resin under 8.0 M HCl conditions until higher concentrations of zinc were used where the resin becomes overloaded. The 2.5 M HCl trial indicated the Cu had no affinity to the resin while the Zn had a high affinity with low concentrations. This means the copper can easily be separated from the zinc with a 2.5 M HCl elution which would remove the Cu with the solution and the Zn would remain adhered to the AG-1x8 resin.

CONCLUSION & FUTURE WORK

- The results from 0.1 M HCl AG-1x8 and 2.5 M HCl DGA resin are pending. The analysis of these results combined with the above findings will help determine the amount of resin to be used in packed columns for future Cu-67 production separations.
- Investigate a wider range of concentration levels of HCl for the Amberchrome AG-1x8 and DGA resins.
- Vary the concentrations of of Cu, Zn to help determine the resin limits.
- Include Fe into the Cu, Zn matrix to determine the separation efficiency with various concentrations of HCl with the AG-1x8 and DGA resins.

REFERENCES

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(2) M. Alex Brown Metal Oxide Sorbents for the separation of Radium and Actinium (2020) 20472-20477

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