Electrorefining Uranium

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Background

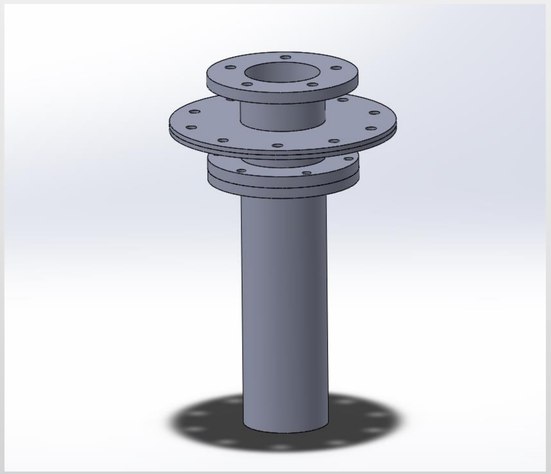
- Electrorefining is the process of metal electrodeposition through electrolysis and is often called pyroprocessing due to the high temperatures involved.
- When an electric potential is applied between an anode of impure metal and a cathode, the atoms of the anode are electrotransported to the cathode resulting in a pure deposit of metal.
- The redox potential, the applied electrical potential where this process occurs, for uranium is higher than the redox potential for water. To avoid preferentially oxidizing water, a non-aqueous, molten salt treatment is required.
- Pyroprocessing has been extensively applied to the reprocessing of spent nuclear fuel such as from the Experimental Breeder Reactor at Argonne National Lab.
- Pyroprocessing is a crucial step in transitioning spent fuel to useable fast reactor fuel and is an import step forward in closing the nuclear fuel cycle.

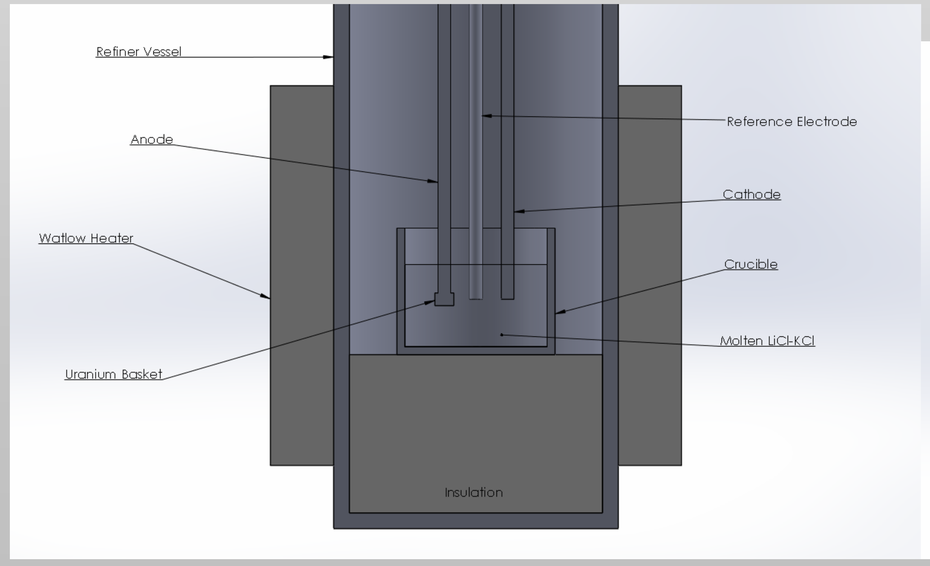
Objective

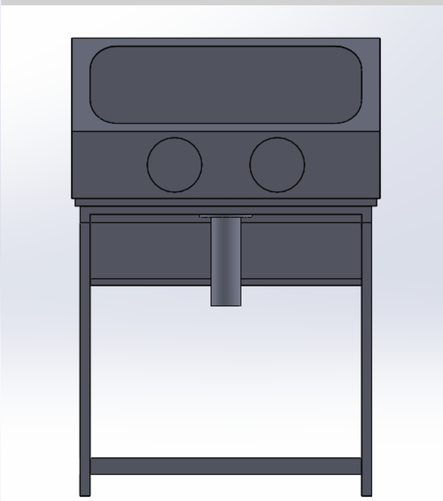
To design, fabricate and operate a molten salt electrorefiner, to efficiently purify depleted uranium samples and to extend the knowledge of electrolysis to uranium metal.

Experimental Setup

- Due to the pyrophoric properties of uranium metal and the hygroscopic properties of LiCl-KCl, all experiments must be conducted in a low O_2 and H_2 positive pressure argon glove box.
- Limited space inside the glove box necessitates the use of a heater well to house the experiment below the glove box floor.
- A stainless steel crucible will be used to melt and contain the salt.
- A stainless steel cathode and anode with an attached basket will be lowered through the heater well into the molten salt.
- A reference electrode will also be lowered into the salt to measure the voltage between the anode and cathode.
- An external power supply will be used to deliver a high amperage, low voltage current to drive the redox reaction.







Future Work

- Build and install the heater well into the glove box.
- Investigave In house production of LiCl-KCl eutectic and its integration into the refining process.
- Development of a sophisticated process controller to autonomously control the refining process.
- Modify the refiner system to include salt agitation in the form of a rotating anode and cathode system.
- Investigate the use of $CdCl_2$ to produce UCl_3.
- Develop a process to remove the molten salt from the cathode deposits in order to check the purity of the deposits.
- Add a recirculation and water trap system to increase the purity of the argon environment.

References

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