SEPARATION OF URANIUM AND MAGNESIUM BY MOLTEN SALT ELECTROREFINING

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Recovery and potential recycle of irradiated metallic uranium fuel rods often requires removal of a protective cladding material such as magnesium, zirconium or aluminum. The majority of this cladding may often be stripped mechanically. It is also worth removing any residual layers whilst minimizing the loss of uranium in order to reduce the generation of radioactively contaminated waste. In this study, magnesium is used as an example of a cladding material that is chemically more reactive than uranium.

Experimental study on metals electrorefining using molten chloride salts electrolyte was conducted in two parts: (a) magnesium decladding by electrorefining process and (b) uranium electrorefining of spent uranium fuel rods. This study focused on the effect of electrorefining process parameters, including temperature; current density; electrolyte chemical composition; and molten salt stirring rate to obtain operating windows for minimal uranium contamination in the electrolyte for the magnesium electrorefining and for minimal magnesium contamination in the cathodic products for the uranium electrorefining.

Investigation of magnesium electrorefining, was carried out with a reference electrolyte of 55 mol.% LiCl, 40 mol. % KCl, and 5 mol.% $MgCl_2$. The investigation was designed to search for minimum uranium contamination in the electrolyte. Conclusions drawn from obtained results suggest the application of:

1. low temperatures, around 400-425 ^oC
2. low current density (up to 12 mA cathodic or 60-80 mA/cm^2 anodic current density)
3. $MgCl_2$ content in the electrolyte not less than 2.5 mol.%.
4. High stirring rate, such as 4 Hz or more for enhanced ion transfer.

Typical plots of the measurements of uranium contamination of salt as a function of temperature and the anodic dissolution of magnesium as a function of current density are shown in Figures 1 and 2. Figure 3 shows the cathodic product analysis as a function of $MgCl_2$ content during uranium electrorefining.

Investigation of uranium electrorefining, was conducted with a reference electrolyte of 54 mol.% LiCl, 40 mol. % KCl, 4-5 mol.% $MgCl_2$, and up to 1 mol. % UCl_3, which was isothermally maintained at a process temperature of 425 ^oC. The investigation searched for minimum magnesium contamination in the cathodic product. Conclusions from this study suggest the application of:

1. Low anodic current density, up to 0.1 A/cm^2, to produce uranium deposit with minimum magnesium contamination.
2. High ratio of U/Mg in the electrolyte, at least 1, to produce dense and well-adhering uranium deposition at the cathode.
3. Low stirring rate, such as 1 hZ or less.

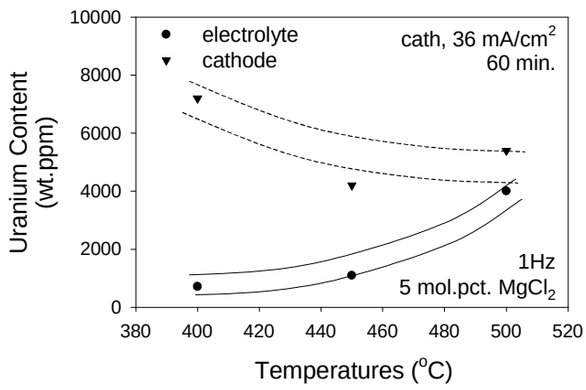

Figure 1: Uranium dissolution in the salt bath as a function of temperature.

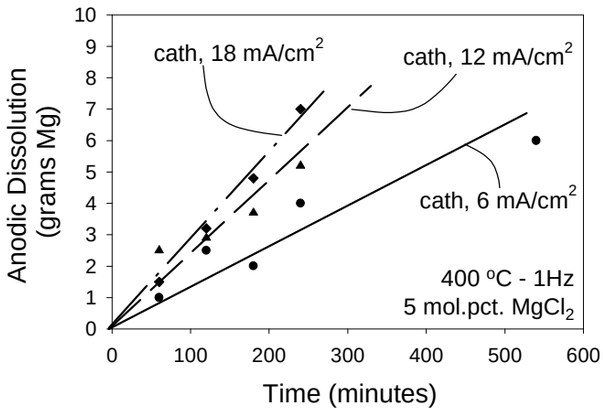

Figure 2: Magnesium anodic dissolution as a function of time at 400 ^oC.

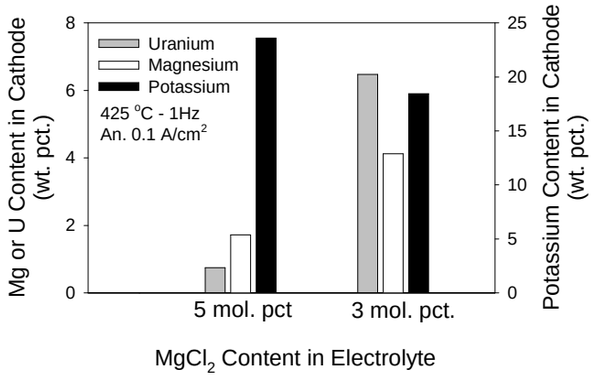

Figure 3: Potassium, magnesium and uranium content in the cathodic product.

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