Safeguarding Protactinium through Surrogate Niobium Chemistry

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Objective & Mission Relevance

Objective

Gain insight on the redox and coordination chemistry of thorium fuel cycle intermediate protactinium (Pa) by studying the electrochemical behavior and oxidation state of surrogate Niobium (Nb) while complexed with biologically-challenging chelators with the purpose of applying this knowledge for improved safeguards considerations and aqueous reprocessing.

Mission Relevance & Motivation

Safeguards require:
- Increased knowledge of Pa separation behavior.
- More comprehensive safeguards practices for 233Pa and 233U.

Group V chemistry is underdeveloped due to:
- A high tendency towards hydrolysis & stable oxide products.
- For Pa: radioactivity and scarcity of material as well.

Background: Group V Chemistry

Physical Properties

Commonly 5+ or 4+ in aqueous solution. Hydrolysis occurs readily in non-complexing media, decreasing in the order 2+<3+<4+.<5+

Nb > Ta >> Pa

Thus, conditions that allow successful complexation of Nb (vs. hydrolysis) should work for Ta & Pa with less issue.

NbO4 and PaO4 are highly insoluble in HF, and slightly soluble in acids 2+<3+<4+<5+.

Protactinium Purification Plans

A legacy oxide source containing 233Pa will be purified via base precipitation. This procedure is based on previous work done by Brown and Whitaker 12 and Wilson et al. 11

References


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