
Effects of alpha and gamma radiation on complex and metal loaded solvents for advanced solvent extraction processes

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ABSTRACT:

The proposed 3-year research project will investigate the alpha and gamma radiolysis-induced chemical degradation of ligands used for the removal of minor actinides from used nuclear fuel in advanced extraction systems such as ALSEP. We will emphasize organic phase degradation, particularly complex solvents with multiple ligands as well as organic solvents loaded with significant levels of metal ions. The project will also elucidate the major degradation pathways, which is necessary to improve the predictive capabilities of chemical effects in these current processes. This will involve obtaining, in pure form, identified degradation products from these reactions to test their effect on the extraction systems and to gain additional insight in the effect of radiation on advanced solvent extraction processes. The project would address the most important challenges existing in aqueous separations processes currently under development for used fuel treatment. Our efforts will provide a quantitative understanding of the effect of radiation on the organic phase, particularly the less-studied heavy ion (alpha) radiolysis, and its role in the reactions and species that directly affect metal ion distribution ratios and that govern the formation of third phases in these systems. We will utilize a number of different tools available for inducing high LET radiation damage, including a TRIGA[®] reactor and two different ion-beam irradiators with varying dose rates and total dose. We plan to compare the effect of high and low LET and to use mixed radiation with varying high and low LET contributions to simulate anticipated real-world processes.

Specific objectives of the proposed research are as follows:

1. Study degradation products and pathways for gamma and alpha radiolysis of the organic phase using combinations of reagents typical of ALSEP or other advanced extraction systems.
2. Investigate the effect of metal loading in the organic phase on the radiolytic degradation of the organic phase.
3. Investigate the effect of different degradation products on the extraction equilibria of trivalent actinides and lanthanides and the physicochemical properties of the organic phase.