Can proper selection of alumina source increase the retention of technetium during vitrification of nuclear waste?

Richard Pokorny*†[1], Jaroslav Klouzek[1], Petra Cincibusova*[1], Laura Lowy[1], Matous Eret[1], Pavel Hrma[2], and Albert Kruger[3]

[1]University of Chemistry and Technology Prague, Czech Republic – Czech Republic
[2]AttainX, Support Services Contractor to The Office of River Protection, U.S. Department of Energy, Richland, WA, US – United States
[3]U.S. Department of Energy, Office of River Protection, Richland, WA, USA – United States

Abstract

The volatilization of technetium-99 during the vitrification of low-activity waste (LAW) into glass poses a significant challenge. Recycle loops are commonly employed to address this concern; however, they may lead to issues such as sulfate phase formation. Achieving high single-pass retention of Tc (or its non-radioactive surrogate, Re) is thus essential for enabling formulations with high waste-loading. In our prior investigation, we observed markedly enhanced Re retention in a LAW melter feed containing gibbsite as an alumina source compared to a compositionally similar feed using kyanite. To investigate this phenomenon, we formulated representative LAW feeds using different Al-sources-kyanite, gibbsite, boehmite, and corundum-and evaluated Re retention in the resulting glasses. Our findings reveal that boehmite feed exhibits the highest Re retention, closely followed by gibbsite, whereas kyanite and corundum feeds exhibit significantly lower retention. This discrepancy is attributed to the formation of nano-crystalline γ-alumina during heating of feeds containing gibbsite and boehmite. As proposed by Xu et al. (J. Nucl. Mater., 483 (2017) 102-106), γ-alumina might adsorb sulfate-perrhenate melt, which persists in the reacting melter feed following the decomposition of the nitrate-nitrite-carbonate melt.

Keywords: vitrification, Tc/Re retention, alumina

*Speaker
†Corresponding author: Richard.Pokorny@vscht.cz