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*Efficacy of a Solution-Based Approach for Making Sodalite Waste Forms for an Oxide
Reduction Salt Used in the Reprocessing of Used Uranium Oxide Fuel*

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Abstract. This paper describes the various approaches attempted to make solution-derived sodalite with a LiCl-Li₂O oxide reduction salt used to dissolve used uranium oxide fuel so the uranium can be recovered and recycled. The approaches include modified sol-gel and solution-based synthesis processes. As-made products were mixed with 5 and 10 mass% of a Na₂O-B₂O₃-SiO₂ glass binder and these, along with product without a binder, were heated using either a cold-press-and-sinter method or hot uniaxial pressing. The results demonstrate the limitation of sodalite yield due to the fast intermediate reactions between Na⁺ and Cl⁻ to form halite in solution and Li₂O and SiO₂ to form lithium silicates (e.g., Li₂SiO₃ or Li₂Si₂O₅) in the calcined and sintered pellets. The results show that pellets can be made with high sodalite fractions in the crystalline product (~92 mass%) and low porosities using a solution-based approach and this LiCl-Li₂O salt but that the incorporation of Li into the sodalite is low.

1 INTRODUCTION

The current US nuclear fuel process is an open, or *once-through*, fuel cycle where the

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