

GEOPOLYMER WASTE FORMS FOR RADIOACTIVE WASTES

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Key Words: Geopolymer, waste form, radioactive waste, solidification and stabilization, alkali-activated material

Geopolymer formulations, referred to as 'DuraLith', have been developed as candidate waste forms for near-surface disposal of a range of radioactive waste streams in the United States. Examples of these radioactive waste streams include Hanford Low-Activity Waste (LAW), Hanford Secondary Waste (HSW), Sodium Bearing Liquid Waste (SBW) at the Idaho site, and Tank 48H waste at the Savannah River Site. These waste streams exhibit an extremely wide variation in chemical composition and radionuclide content, which pose significant challenges for their solidification and stabilization. In this paper, we will review the development, characterization, and properties of DuraLith geopolymer waste forms for various radioactive waste streams. Metakaolin (MK), blast furnace slag (BFS), and Class F fly ash (FFA) were selected as reactive aluminosilicate materials to produce DuraLith waste forms for these wastes. Numerous composite geopolymers have been investigated, such as FFA/BFS, MK/BFS, and MK/BFS/FFA. The alkaline activator is a tailored solution of the simulated waste stream into which alkali hydroxide and silica fume are dissolved. The testing included key radionuclides such as Tc, I, and Cs, which dominate the risk to the environment. Various enhancers such as tin fluoride and Ag-modified zeolites were employed to improve fixation of radionuclides such as Tc and I. The process of solidification of these radioactive waste streams through geopolymerization was monitored by isothermal calorimetry, rheology, and Vicat needle penetration. Cured geopolymer waste forms were characterized for compressive strength and phase composition and microstructure by XRD and SEM/EDS. Selected samples were tested for leachability of heavy metals and radionuclides after 28 days of curing at ambient temperature according to the ANSI/ANS 16.1 and TCLP leach test procedures. Effects of BFS grades and FFA incorporation on the properties of fresh and hardened waste forms were investigated.

The results show that the leachability indices for key radionuclides exceed the U.S. waste performance requirements and that U.S. EPA limits for retention of hazardous elements were successfully met. The compressive strength exceeded the minimum requirement by factors of up to 20. The results also demonstrate that the waste loading, which is a key factor in the economics of any waste form, can be extremely high for

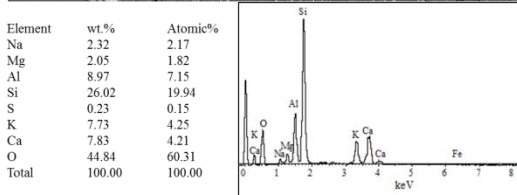
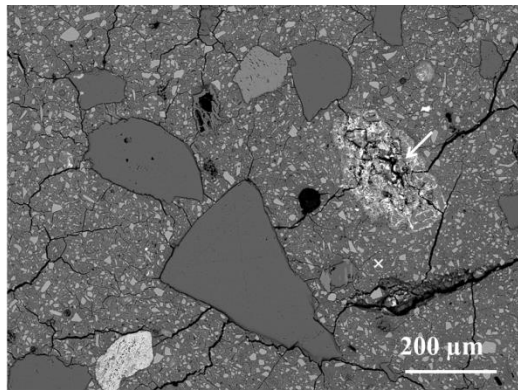


Figure 1. Typical microstructure of a BFS-based DuraLith waste form for HSW. The arrow indicates an iodine loaded zeolite particle. The EDS analysis suggests the matrix phase is an alkali-modified C-A-S-H gel.