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A PHOSPHATE-BASED WASTE FORM PLATFORM FOR EFFICIENT WASTE FORM SOLUTIONS

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Current waste form options for salt-based HLW include glasses, ceramics, glass-ceramics, or glass-bonded ceramics. Two approaches to immobilization of salt wastes have been widely suggested. One is direct immobilization of the full salt with Cl and/or F containing waste forms. The other is to remove the salts prior to immobilizing in a waste form. Due to the low solubilities of chloride/fluoride ions and the evolution of Cl2/F2 gas at elevated temperature, it is not suitable to employ borosilicate as the host for full-salt waste streams. Zeolites and sodalites/glass-bonded sodalites have been extensively studies in the U.S. as candidates for immobilizing chloride pyrochemical wastes generated during the reprocessing of fuel from experimental breeder reactor programs. Waste loading in these materials is limited to ~8 mass % by stoichiometry to form and encapsulate chloride-bearing sodalite. The SYNROC is also not chemical flexible for salt waste streams.

In early studies, phosphate-based glass waste forms had been developed for HLW generated by reprocessing of spent nuclear fuel, particularly for actinides. Currently, Iron-phosphate glass waste forms are being developed under the auspices of DOE-NE that can be used to immobilize salt wastes from the electrochemical reprocessing of used nuclear fuel. In a NEUP project, we are studying composition-property-structure correlations of iron-phosphate glass to immobilize oxide-fuel reduction waste salts. Apatite is the most abundant naturally occurring phosphate on Earth. Phosphate apatite minerals corresponding to the general formula M10(PO4)6(Z)2, referring to hydroxyapatite, fluorapatite, and chlorapatite have been investigated as potential nuclear waste forms to incorporate rare earth elements and actinides, as well as a host phase for waste chloride salt from pyroprocessing of spent nuclear fuel. Alkali, alkaline earth and rare earth ions that go to the M position and halogens that go to Z position as tunnel ions. Here we try to translate scientific research on phosphate minerals (apatite-group materials) and glasses into a waste treatment technology platform for treating molten salt reactor waste. Utilizing this platform, several variations of phosphates can be developed as waste forms based on the waste stream compositions and selected immobilizing matrix.