ENGINEERED STORAGE FORMS FOR THE IMMOBILIZATION OF RADIOACTIVE CESIUM AND STRONTIUM FROM SPENT NUCLEAR FUEL

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ABSTRACT

Ortega, Luis H. M.S.N.E., Purdue University, August, 2006. Engineered Storage Forms for the Immobilization of Radioactive Cesium and Strontium from Spent Nuclear Fuel. Major Professor: Sean M. McDeavitt.

Cesium and strontium (^{137}Cs: $T_{1/2} = 30.07y$; ^{90}Sr: $T_{1/2} = 28.78y$) bearing radioactive wastes are particularly serious radioactive hazards. The goal of waste form development is to immobilize these isotopes and isolate them from the biosphere. In addition, the potential for putting into effect an advanced fuel cycle which separates these isotopes from the bulk of the spent nuclear fuel is a driving force for research to find cheaper and safer ways to treat these potential new cesium and strontium bearing wastes. The separation of these elements is being considered because the majority of the heat load and radiation coming from spent nuclear fuel for the first 300 years comes from cesium and strontium. Steam reforming may be an effective way to treat these cesium and strontium wastes without the high temperatures associated with vitrification and other processes which can volatilize the radioactive elements. Simulated Fission Product Extraction (FPEX) waste streams were created consisting of cesium and or strontium nitrates dissolved in dilute nitric acid. This aqueous solution was reacted with kaolin ($Al_2Si_2O_5(OH)_4$) and carbon at $\sim$700°C under a fluidizing flow of steam or argon. Silica beads were added to the process vessel as a seed material to provide a surface for deposition of the waste material. Under steam, a glass-like material was created with cesium and strontium loadings of 2.77$\pm$0.01 and 0.11$\pm$0.01 mass %, respectively. Under argon the experiments created cesium aluminum silicate ($CsAlSiO_4$) and strontianite ($SrCO_3$) with theoretical maximum loadings of cesium and strontium of 56.6 and 60 mass % respectively.