Contribution ID: **39** Type: **Poster**

Geopolymer WasteForms-derived Industrial Side Streams for Safe Stabilization/Solidification of Radioactive Wastes- A Review

As many countries are looking for ways to meet their commitments to reduce carbon emissions by 2050, they are focused on the ongoing advancement of small modular reactor (SMR) technology as an option for responding to the effects of climate change and future energy demand. To ensure this new technology is viable as a supplement to existing energy sources, careful consideration of radioactive waste management needs to be carefully considered from the early stages of design. As an excellent intermediate with environmental benefits and many favorable characteristics, geopolymers synthesized by utilizing industrial side streams (ISSs) can be directly used as wasteforms for radioactive wastes via stabilization/solidification technologies. Application of ISS as a feedstock into geopolymer wasteforms (GWF) can effectively enable resource utilization, and reduce or even eliminate environmental and economic issues while avoiding the limitations associated with insufficient landfill disposal sites. This work provides a critical review of recent progresses of research on the use of ISS-based geopolymers used as wasteforms for S/S of radioactive wastes. GWF consists of an alkali/acidic activator and cementing precursors-metakaolin, coal fly ash, blast furnace slag, mine tailing, etc., or a mixture of two or more of them. Each properly designed GWF can exhibit both higher early-later strengths and lower leaching indexes, due to extensive differences in feedstock physical/chemical characteristics. The main reaction products of ISS based-geopolymers such as N–A–S–(H)/(N,C)–A–S–H gels coexisting with unreacted crystalline phases effectively promote the mechanisms and efficiency of different wasteforms on the solidification of radioactive substances. From all these aspects, it is concluded that the various ISS-based geopolymers are considered the next-generation low-carbon cement wasteforms for safe disposal of radioactive waste and therefore highly likely to become part of the nuclear industries toolbox for waste solidification.

Keywords: Small Modular Reactor, Industrial Side Streams; Geopolymer WasteForms; Radioactive wastes; Stabilization/Solidification;

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Track Classification: Topical Group A: SMR Design, Technology and Fuel Cycle: Track 2: Advanced fuels, reprocessing, waste management and decommissioning aspects for SMRs –Safety, Design and Technology