NEUP Nuclear Energy University Programs
U.S. Department of Energy

Off-Gas Treatment: Evaluation of Nano-structured Sorbents for Selective Removal of Contaminants

PI: Vivek Utgikar- University of Idaho

Collaborators: Eric Aston- University of Idaho

Patricia Paviet-Hartmann, Piyush Sabharwall- Idaho National Laboratory

Program: FCR&D: Nanonuclear R&D

ABSTRACT:

Capture and immobilization of volatile radionuclides present in the off-gas from used nuclear fuel (UNF) recycling operations is an essential component of an integrated nuclear waste management system. Radionuclides of particular concern are the long-lived ^{129}I, that tends to bioaccumulate and affect the metabolism in humans, and ^{85}Kr, a chemically inert radioisotope that continues to accumulate in the environment. Control of emissions of these contaminants is necessary to comply with the stringent regulatory limits placed on their releases to protect human health and environment.

Off-gas treatment processes based on cryogenic distillation, absorption in solvents and membrane separations suffer from several drawbacks including cost, presence of corrosive materials and the radiation stability of materials. *The goal of the proposed research is to evaluate nanostructured sorbent materials for their effectiveness in removing and immobilizing the contaminants of interest for the off-gas treatment from the UNF recycling operations.* The specific objectives defined for the research are:

1. *To synthesize and characterize various nanosorbents for the removal of radioactive contaminants from the off-gas,*
2. *To determine the adsorption isotherms for contaminants of interest (I, Kr) on selected sorbents,*
3. *To investigate the immobilization of the contaminants in a durable form, and*
4. *To develop a process model that can be used for the design of the capture and immobilization system for the radionuclides in the off-gas.*

Nanosorbents based on activated carbon and zeolites will be synthesized and characterized with respect to their surface area and other properties. Continuous column experiments will be conducted at various operating conditions to obtain the adsorption equilibria of individual components and those in multicomponent mixtures. Mathematical models will be developed to describe the performance of the sorbents, and the model validated from the experimental data. A comprehensive system will be developed for the treatment of the off-gas on the basis of the model and the experimental data.

Development of advanced fuel cycles is essential for the sustainability and growth of the nuclear power. Achieving near-zero emissions of radionuclides by capturing them from the off-gas of recycling operations is one of the integral challenges in the development of the innovative technologies necessary for this purpose. The proposed research addresses a key need in development of off-gas treatment, targeting the emission of radionuclides using nano-structured materials. The studies conducted to accomplish the objectives outlined above will yield data on the adsorption isotherms of individual contaminants and mixtures on different. Theoretical modeling of the processes will offer fundamental insight into the mechanisms, and allow us to design and predict the performance of the system. The predictive capability of the proposed research will help further the progress of the next generation of fuel cycle.