NUCLEAR ENERGY UNIVERSITY PROGRAMS

Adsorptive Separation and Sequestration of Krypton, I and C14 on Diamond Nanoparticles

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Abstract

The objective of this research is to address the separation and sequestration of krypton (Kr) from iodine (I) using nano-sized diamond particles, retaining these elements in diamond either until they decay to background levels or are used as a byproduct. Due to the size difference of these atoms/molecules, the project team expects that optimizing the process variables will allow Kr and I to be separated from each other in a stage-wise manner and simultaneously stored in diamond. An adsorbent will then be used to remove and store carbon dioxide from the CO_2-rich stream.

An early study showed that 23.3 percent of Kr by mass could be loaded into interstitial sites in a diamond lattice at 700°C. With micron or nano-sized particles having a larger relative surface area, the loading capacity should increase. Other studies show that hydrogen storage capacity could increase significantly by using boron-doped, irradiated diamond particles. The specific objectives of this project are to:

- Investigate pure component adsorption capacity of Kr and I by diamond particles by the field enhanced diffusion with optical activation (FEDOA) method, a large-scale process that takes advantage of thermal, electrical, and optical activation to enhance diffusion into the diamond structure.
- Identify the best adsorbent or method for CO_2 capture and long-term storage.
- Investigate pure component adsorption capacity of Kr and I by boron-doped, irradiated diamond particles by the FEDOA method, and identify the best materials for further mixture study.
- Optimize the FEDOA process parameters—temperature, pressure, bias voltage, and sorption time—both experimentally and using Monte Carlo simulation.
- Investigate adsorption capacity of diamond nanoparticles for the adsorption of Kr and I from their binary mixtures.
- Investigate adsorption capacity of Kr and I mixtures in the presence of CO_2 by diamond nanosized particles.
- Develop design parameters for adsorptive separation and sequestration of Kr, I, and CO_2 for long-term storage.