

Task 9

Design and Evaluation of Processes for Fuel Fabrication

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GOAL AND BACKGROUND

One of the primary concerns in selecting a fuel matrix for actinide-bearing fuels, such as those for transmutation systems, is fuel fabrication. Fuel fabrication technologies for the fabrication and re-fabrication processes must meet several technical considerations, such as minimizing secondary radioactive waste streams, economic viability, reasonable capital outlay, and must be easy to maintain over the transmuter core life cycle. Additionally, the fuel type chosen must be easily manufactured in a remote environment. The volatile behavior of americium during thermal processing further complicates these goals. Currently, the national program is investigating a number of candidate fuel matrices: metallic, ceramic, dispersion, nitride, and carbide/TRISO, just to name the leading candidates.

This project examines the manufacturing processes currently under consideration for these fuel types, as currently envisioned by the Argonne National Laboratory-West manufacturing group. Each fuel type requires developing a distinct remote fabrication process. Conceptual fuel fabrication processes for the fuel types will be developed in conjunction with ANL. This knowledge allows scientists to make an informed selection regarding which candidate fuels require further development and irradiation testing for a transmutation system.

OBJECTIVES AND RESEARCH METHODS

The first phase of the research effort devoted time to the analysis and assessment of the multiple steps required in the manufacture of different fuel types. Following collection of pertinent manufacturing and process-related information, a database was created to provide information on characterizing the design, operations, and cost implications of various fuel choices. Researchers anticipate that the fabrication processes for different fuel types would differ in terms of equipment types, throughput, and cost. Due to the interactive nature of the modeling and design of the fuel fabrication processes, close cooperation with the fabrication development group at ANL and other researchers is essential to the long-term success of this effort.

Conceptual modeling of a sample manufacturing process was performed by developing a 3-D model of a sample process, its flow of materials, and the equipment required to handle the material flow. These models aid in the identification of issues, costs, and impacts of each fuel type on the fuel manufacturing process and the transmuter fuel cycle. Detailed process models were developed after outlining preliminary requirements for large-scale fuel production in a remote environment for a network of transmutation systems. Realistic simulations permit the prediction, analysis, and elimination of potential problems. The dynamic system simulation detects inconsistencies and possible design flaws. It allows for timely modifications to previously unsuspected problem areas.

RESEARCH ACCOMPLISHMENTS

The UNLV research team achieved the following tasks during the first year of research:

- Survey of candidate transmutation fuels, coupled with a detailed evaluation of the identified fuel manufacturing processes following criteria established by the national fuel development program;
- Conceptual computer modeling of one manufacturing process allowing the identification of areas where automated processes are crucial to maintain the required throughput rates;
- Mr. Richard Silva, M.S. student, developed an initial work cell simulation with two robots. He will continue to develop detailed 3-D process simulation models for his thesis project; and,
- Mr. Jae-Kyu Lee, a Ph.D. student, developed a conceptual methodology for vision-based hot cell supervision and control.



Dual slave arm end effector in the UNLV Robotic Hot Cell Unit. The master is configured identically, and is guided by a human operator.

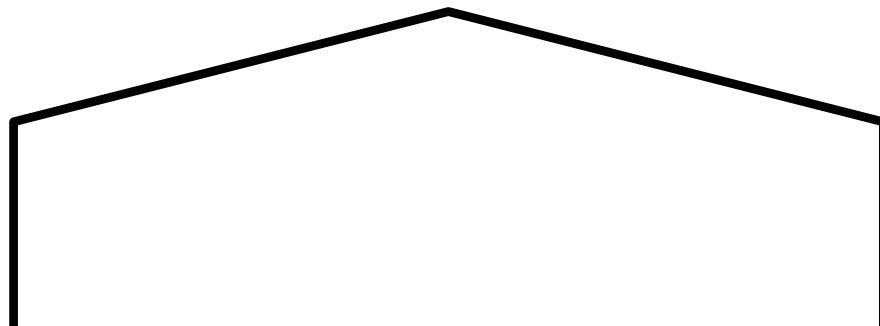
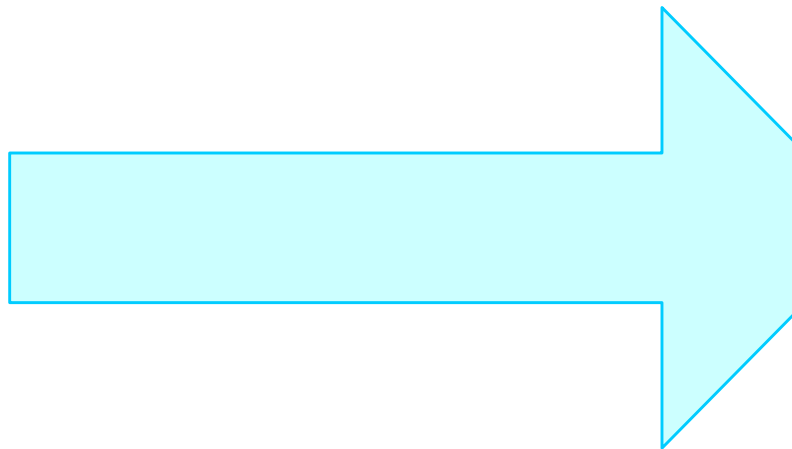
CONTINUED PROGRESS AND FUTURE GOALS

The second phase of the project involves the identification and analysis of remote manufacturing technologies required for efficient large-scale remote fuel fabrication. Process models developed in the project would be available to Transmutation Program personnel for a more accurate definition of the impact of fuel choice on the transmuter fuel cycle. In particular, the process models could better define relative process losses, waste generation, and capital cost for the three potential fuel types. These process models would allow the early identification of issues that may disqualify a fuel type for consideration in a transmutation system in the system specification process. Models will

HIGHLIGHTS

- A Transmutation Research Program seminar presentation by Mr. Jae-Kyu Lee, Ph.D student, and Dr. G. Mauer, P.I., entitled “Transmuter Fuel Fabrication Process.”
- Presentation of a paper entitled “Transmuter Fuel Fabrication Processes” by J.-K. Lee at the ANS Student Mini-Conference in Reno, Nevada, November 2001.

also allow more accurate definitions of requirements for automation.



Possible Configuration for Powder Processing (e.g. Oxide or Nitride Fuel) Fabrication Work Cell.

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