EVALUATION OF ALTERNATIVE PARTITIONING/TRANSMUTATION SCENARIOS USING TRANSMUTATION IN LIGHT-WATER REACTORS (LWRS)

E. D. Collins, J-P. Renier, B. Del Cul and B. Spencer
Oak Ridge National Laboratory, 1 Bethel Valley Road, Oak Ridge, Tennessee 37831-6170
(collinsed@ornl.gov)

Abstract

Previous Advanced Fuel Cycle Initiative (AFCI) studies were made to assess the effects of the existing accumulation of LWR spent fuel in the United States on the capability to partition/transmute actinides using existing and advanced LWRs. The concept of treating the "oldest fuel first" indicated that significant advantages could be gained in both partitioning, transmutation, and in overall cost reduction[1,2].

The processing scenarios previously evaluated assumed that (1) 2000 MT/year of spent fuel, irradiated to 45 GWd/MT and decayed for 30 years is processed; (2) recovered plutonium and 90% of the neptunium are transmuted in LWR MOX fuel; and (3) minor actinides, consisting of americium, curium, and 10% of the neptunium are transmuted in "burnable poison" type targets.

Results of the previous study showed that significant benefits could be obtained, including (1) lower costs for partitioning and transmutation and for storage of spent fuel, (2) maintenance of proliferation resistance for the fissile plutonium in spent fuels, and (3) extended lifetime for the repository.

The lower costs would be achieved primarily because no capital investment for a special transmuter reactor (fast reactor, accelerator-driven system, etc.) would be required. Instead, only existing and new LWRs would be utilized.

Moreover, no new storage capacity could be needed for spent fuels and irradiated targets because the number of spent fuel assemblies would remain the same after the scenario is begun. Even though the total inventory of plutonium would rise during the early cycles, ~98% of the plutonium would be contained in stored spent fuel and would be protected by high radiation (the "Spent Fuel Standard"). This is because the spent fuel would be reprocessed and re-irradiated at intervals within which the fission products, ^{137}Cs and ^{90}Sr, both with half-lives of ~30 years, exist in significantly high concentrations.

The lifetime of the repository would be extended significantly because all of the plutonium and minor actinides would be "in process" or "in storage" and only fission products would be put into the repository. Previous results showed this scenario could be operated for more than ten partitioning-transmutation cycles (>300 years). Transition to a fast reactor transmutation scenario would be possible anytime during this time period that fast reactors were needed for other purposes. However, in the event of a cessation of nuclear power, transfer of all of the plutonium and minor actinides from the storage inventory into the repository might become necessary. Thus, continuing studies have been made to evaluate alternatives to the partitioning/transmutation scenario to minimize the effect of such an event onto repository operations. Results of these studies will be presented.

REFERENCES

[1] G. D. Del Cul, B. B. Spencer, and E. D. Collins, "Fuel Cycle Advantages Resulting from the Significant Inventory of U.S. Spent Fuel," Proceedings of the Global 2003 Conference, American Nuclear Society (Nov. 2003), pp. 724−727.

[2] E. D. Collins and J. P. Renier, "Evaluation of Actinide Partitioning and Transmutation in Light Water Reactors," Proceedings of Atalante 2004 Conference (June 2004).