Summary of Session 3

Chairman: Dr. P. Wydler

The contributions to this session covered studies of different transmutation systems (PNC, JAERI, KAERI), investigations relating to the P&T fuel cycle (JAERI, Belgonucléaire/EdF), and a target irradiation experiment with Tc-99 carried out in the Petten thermal High Flux Reactor (HFR) in the framework of the EFTTRA co-operation. Most of the important issues and options were addressed in the session including critical and accelerator-driven fast reactors with different types of fuel (oxide, nitride, molten salt) and wet or pyrometallurgical reprocessing, as well as different recycling modes (homogeneous, heterogeneous with inert matrices).

An option which relied primarily on proven reactor technology was to recycle the nuclides to be transmuted in a normal fast reactor. A comparison of different recycling modes for MAs and Tc-99 in a fast reactor was presented by PNC. Relatively high transmutation rates were reported for a case where Np was dispersed homogeneously in the core and Am, Cm and rare earths were recycled heterogeneously in target subassemblies in the blanket region. However, to preserve the safety characteristics of the core, the fraction of MAs in the fuel had to be restricted to about 5 wt%. For the transmutation of Tc-99 a new target subassembly concept using "duplex pellets" with zirconium hydride moderator was proposed.

Accelerator-based systems had the advantage that the deterioration of the core safety characteristics with increased MA concentrations can be compensated by the subcriticality of the core. Three accelerator-based systems for burning MAs were mentioned. In the framework of the OMEGA programme, JAERI investigates a solid system based on fast reactor technology (nitride fuel / sodium coolant) as also a "fast" molten salt system (molten chloride target / fuel) as a more advanced option, both systems being optimised for a high support ratio in the double stratum fuel cycle. An overview of the systems and the supporting R&D was presented, and a lead-based chloride salt was proposed as an alternative fuel for the molten salt system. The system studied by KAERI incorporated features of the Los Alamos ATW system (lead target, molten fluoride salt) and had an intermediate neutron spectrum in the core. A graphite reflector with a softer neutron spectrum was provided, but was found to be unsuitable for burning FPs at an interesting rate.

The current R&D status for the nitride fuel cycle at JAERI was summarised in an overview paper. Pellet-type mixed nitride fuel, fabricated by a conventional route, had been characterised and irradiation-tested in JMTR to a burnup of more than 5 per cent FIMA with good results (no pin failures, low FP releases), an alternative fabrication route for nitride fuel particles by the sol-gel method had been investigated, and the pyroprocess for reprocessing the fuel had been further evaluated; reprocessing experiments with NpN and PuN using laboratory-scale electrorefiners were about to begin.

The fabrication of target pins for the heterogeneous recycling of Am would be associated with higher radiation levels than the current MOX fabrication. In a joint study, Belgonucléaire and EdF had estimated the resulting dose rate increases and impact on the shielding for the different fabrication stages. Dose rate increases up to a factor of 2800 in the case of a transfer canister were predicted. Validation experiments were performed to assess the uncertainties of the calculations.

The EFTTRA co-operation aimed to investigate the behaviour of MA and FP targets during irradiation experimentally. In an irradiation of six metallic Tc-99 rods in the Petten HFR, more than 6 per cent of the Tc-99 was transmuted to stable Ru-100. ECN Petten performed the PIE for one of these rods and obtained reasonable agreement between measured and predicted ruthenium profiles provided that a Monte Carlo code with a point cross-section library was used in the analysis. A new measurement of the thermal absorption cross section of Tc-99 in the HFR may help to resolve remaining small discrepancies.

Regarding the evolution of the reported activities since the Cadarache P&T meeting in 1994, one could notice a move from the innovative to a stable development phase. Efforts in the fuel and target development area had been strengthened, and the concept of the double stratum fuel cycle, including accelerator-based MA burners, had found wider acceptance. Evaluations of the radioprotection implications had been initiated and filled an important gap. Considering the still not very clear incentive and goals for transmuting the fission products, the analytical and experimental effort devoted to studies of the Tc-99 transmutation was noticeable.