

EXECUTIVE SUMMARY

Partitioning and transmutation (P&T) has gained interest during the past decade and the OECD Nuclear Energy Agency (NEA), in response to the interest from member countries, has included P&T in its programme of work since 1989. The information exchange meetings are one of the key components of this international project, providing experts with a forum to present and discuss current developments in the field.

Seven information exchange meetings have so far been organised (Mito, Japan in 1990; ANL, USA in 1992; Cadarache, France in 1994; Mito, Japan in 1996; Mol, Belgium in 1998; Madrid, Spain in 2000 and Jeju, Korea in 2002). This 7th meeting was generously hosted by the Korea Atomic Energy Research Institute (KAERI), the Korea Electric Power Research Institute (KEPRI) and the Korean Nuclear Society (KNS), and was held in co-operation with the European Commission and the International Atomic Energy Agency.

In keeping in mind the main objectives and roles of P&T in nuclear energy, the 7th meeting focused on the current state of developments and progress made, and future work to undertake in the P&T field.

The 7th meeting was opened with a general session in which nine national and international programmes on P&T were addressed. As major national programmes, current P&T programmes in Japan, the United States, the Republic of Korea, France, the Russian Federation and China were presented. International programmes led by the European Commission (EC), the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (NEA) were then addressed.

Six technical sessions followed on the main scientific and technical issues in the P&T field.

- Session I: Fuel Cycle Strategy and Future Reactors.
- Session II: Progress in Partitioning and Waste Forms.
- Session III: Progress in Fuels and Targets.
- Session IV: Progress in Materials: Spallation Targets and Advanced Coolants.
- Session V: Progress in Physics and Nuclear Data.
- Session VI: Transmutation Systems (Critical and Sub-critical): Design and Safety.

During Session I on Fuel Cycle Strategy and Future Reactors, 15 papers were presented dealing inter alia with national and international policy, overviews of R&D programmes at NRI Rez, in the Czech Republic and at FZK in Germany, multi-recycling issues and various fuel cycle schemes studies such as ORIENT, Double Strata, CORAIL, PEACER and a phase-out scenario based on fast neutron ADS systems, core design and optimisation for TRU burners, new concepts of transmuters including critical and sub-critical molten-salt reactors, long-lived fission product transmutation studies, thorium-based plutonium and minor actinides transmutation in PWRs.

Nineteen papers were presented during Session II on Progress in Partitioning and Waste Forms. As for minor actinide partitioning, major progress made in Japan, the Russian Federation and the United States was reported. In Japan, a simplified PUREX process was proposed with co-extraction of U, Pu and Np. In Russia, the DOVITA process was extended to MAs although the reprocessing of MA fuels still seems to be problematic. In the United States, a dual tier strategy was proposed. In the first tier, Np/Pu are recycled in LWRs, in the second tier remaining Np/Pu and other MAs are burned in a fast spectrum combined with ADS. For the problematic An/Ln separation, the progress made in both aqueous and pyro-techniques was addressed. The problem of long-lived fission products was also addressed in several papers.

During Session III on Progress in Fuels and Targets, 12 papers were presented covering research areas from fuel preparation and basic properties, fabrication processes and irradiation programmes to design and modelling calculations. Regarding chemical forms, papers addressed alloys, inter-metallic dispersion, oxides (pellets, VIPAC), nitrides, molten salt and fission product targets (Tc and I). Since the last meeting, several post-irradiation experiments such as T4, MATINA1, THERMET and RIAR programmes have been completed, and new irradiation tests for transmutation such as T5, CAMIX-COCHIX and FUTURIX are being carried out or planned. Experimental studies on Am-bearing fuels have been undertaken, although still at laboratory scale. Remaining questions include behaviour of He during irradiation, selection of inert matrices, chemical form for transmutation of ^{129}I , processing of Cm and metallic vs ceramic fuel. It was stressed that international collaboration is essential for further development with effective use of fabrication facilities, reactors, PIE facilities and compilation of existing data.

During Session IV on Progress in Materials: Spallation Targets and Advanced Coolants, 10 papers were presented dealing with validated data and tools in the area of materials, thermal hydraulics and engineering design to enable the design of ADS components, mainly the spallation target. More specifically, fundamental experiments and physical model development, applied large-scale experiments such as CIRCE at ENEA (Italy) and KALLA at FZK (Germany), and design validation of spallation targets including next generation spallation source projects such as ESS, SNS, JSNS, and the international MEGAPIE initiative were addressed. With regard to target design options, technical issues on closed/open spallation target systems, the windowless option and the solid window option were discussed.

Session V on Progress in Physics and Nuclear Data addressed, through the 16 papers presented, mainly recent studies of basic physics processes on ADS, reactor-based and differential accelerator-based integral experiments for cross-section and basic nuclear data validation and measurements, development of specific measurement techniques, new simulation tools for ADS and transmutation systems, and studies of transmutation scenarios and devices. The experiments on basic physics processes in mock-ups of transmuter/ADS and associated simulation benchmarks enable one to develop the correct concepts to understand these systems and to identify the needs and deficiencies of the currently available nuclear data. A combination of reactor-based and differential accelerator-based experiments using new specific measurements, should provide basic nuclear data required as well as models needed to predict non-measured data. The results of these efforts will be incorporated into new simulation tools for ADS and transmutation systems (models and data) to optimise concepts of transmutation scenarios and devices.

During Session VI on Transmutation Systems (Critical and Sub-critical): Design and Safety, 19 papers were presented. A great number of options are still under evaluation for transmutation facilities. For both critical and sub-critical systems, a fast spectrum is the most favourable option. Regarding primary coolants, Pb-Bi is in general considered as the reference option, but Na, gas and molten salt are being studied as possible alternatives. Well-proven MOX fuel is proposed for

demonstration plants. Investigations into more advanced fuels such as metallic fuels, nitride fuels, metallic thorium-based fuels, mixed uranium-transuranics carbide, molten-salt bearing plutonium and minor actinides are being made. As for the targets, solid tungsten targets cooled by sodium or liquid Pb-Bi targets are under consideration. Concerning target design options, the solid window configuration is considered worldwide as the reference, while the windowless option is being studied for two Pb-Bi cooled target systems in Europe. For the ADS power range, it varies from 40 MW for the Belgian MYRRHA, 80 MW for the European PDS-XADS, 100 MW for the US ADTF to 1 000 MW for the Korean HYPER system. Based on the current design of the 80 MW European PDS-XADS cooled by Pb-Bi, a comparative safety analysis between Na and Pb-Bi shows an advantage of Pb-Bi coolant in case of an unprotected loss-of-flow scenario. A proper design will provide sufficiently higher cooling capability of the reactor core preventing from cladding and fuel overheating. Two experimental facilities – SAD and TRADE – were presented.

A panel discussion was organised at the end of the meeting. The main theme of the discussion was perspectives for the future development of P&T. Seven panellists presented their thoughts on the issue, followed by an open discussion involving all participants. The following points were emphasised during the panel discussion:

- The role of P&T must be considered in a global future nuclear power context, including the economic aspects, for example in the form of a cost/benefit analysis.
- An international consensus on performance criteria for P&T should be established.
- The R&D needs to be prioritised, due to the limited resources available.
- The nuclear waste form, following P&T, must be fully understood in order for the performance of P&T to be clearly and efficiently evaluated.
- It is absolutely essential to have closer collaboration between P&T specialists and the radioactive waste management community responsible for the development of geological repositories. In addition, good measures for repository performance must be developed to better connect the two communities.
- International co-operation is crucial, not at the micro scale, but at the macro scale. A kind of burden-sharing collaboration is preferable.

The meeting was closed by the scientific chairman, Dr. Dave Hill. The 8th information exchange meeting is provisionally scheduled to be held in Las Vegas, New Mexico, USA in autumn 2004.