Summary of Session 4

Chairman: Dr. L.H. Baetslé

Considering the overall perspective for P&T, the first task to be tackled was partitioning, because otherwise transmutation would be an unrealistic endeavour. Partitioning was seen as an extension of the closed fuel cycle to those nuclides which constitute a potential and/or an intrinsic hazard. The obvious starting point of partitioning was the source term, where hazardous and long-lived nuclides were brought together with less toxic and short-lived nuclides; and that was the high-level waste solution.

If an analysis was attempted from that view point, methods which had been developed especially for that purpose should be considered. Three papers dealt with that subject directly:

- Products and wastes from 4-group partitioning process developed in JAERI (DIDPA process), by M. Kubota and Y. Morita of JAERI.
- Minor actinide separations: recent advances at the CEA (DIAMEX process), by A. Leudet, B. Boullis, C. Madic of CEA.
- The state of the art on nuclides separation in HLLW by TRUEX process, by M. Ozawa, Y. Koma, Y. Tanaka and S. Shikakura of PNC.

These methods were already under development during the previous NEA information exchange meeting. The highlights of these papers were as follows:

For the JAERI DIDPA process, the flowsheet was fully integrated and was capable of partioning the HLLW nuclides into the following groups:

- TRU group
  - Am-Cm
  - Lanthanides
  - Np-Pu
  - U
- Platinum group metals (PGM) and Tc
- Cs-Sr

The process had only one drawback, that was the HLLW had to be partially de-acidified. Impressive separation and recovery yields had been reported (99.9, 99.5). The process produces only moderate amounts of secondary wastes (128 kg $NaNO_3$/tHM).

The DIAMEX process (CEA), permitted the quantitative extraction of MA from HLLW by the use of malonanide molecules (DMDBTDMA). However, continuous progress had been reported in the synthesis of new extractants with even better properties. The separation of An-Ln had not yet been demonstrated unequivocally and further progress was needed, but the prospects were good that a fully "saltfree -- high acid" process would become operational.

Concerning the TRUEX process (PNC), the flowsheet was a solid improvement of the original ANL flowsheet, since a number of "salt free" re-agents had been introduced and were successful. The flowsheet looked complicated but was, in fact, an integrated series of liquid extraction and strip operations providing: An-Ln fraction; plutonium; and Mo-Zr-Ru (contaminants recycled).

A major point to be noted was the direct use of HLLW solutions without dilution or de-acidification.

Closely associated with these "encompassing" partitioning methods, some very specific advances had been reported:

- Selective extraction and transport of cesium with CALI[4]ARENES crown CRWN from radioactive liquid wastes, by J.F. Dozol et al. from CEA.

These new molecules, with very complex structure, were capable of extracting selectively Cs-137 from a variety of active solutions, including HLLW. Currently, the kinetics were slow, but progress may be expected (contact phase, temperature, etc.):

- Partitioning of minor actinides from rare earths by solvent extraction with D 2 EHPA, by J.-H. Yoo et al.

This technologic development was a necessary step in the mastering of more elaborate partitioning methods.

A very special type of partitioning technique was the pyrometallurgical partitioning approach. This technology needed to be considered as a step in the future, when very highly irradiated targets and fuels would be produced in fast reactors and, possibly, in ADT facilities, to the extent that multi-recycling of such targets was required. Three papers from CRIEPI and associates dealt with this subject:

- Molten salt electrorefining to separate TRUs from rare earth elements, by T. Hijikata et al.
- Pyrometallurgical processing technology development, by T. Koyama et al.
- Development of pyrometallurgical partitioning technology of long-lived nnuclides -- development of salt wastes treatment technology, by Y. Sakamura et al.

Pyrometallurgical techniques were difficult to implement, because of the "moisture" and, sometimes, the "oxygen" interference in the processes. But they had a fundamental merit that radiation damage and decay heat emission did not play a significant role, and that criticality risks were minimal.

The technological requirements were, however, much more severe than those for aqueous methods:

- HLLW must be denitrated and chlorinated.
- Electrochemical processes were complex.
- Separation factors were, generally, smaller.
- An important technological effort had been accomplished in the electrorefining, but much needed still to be done.
- Waste issues had been studied -- in particular, how to treat unrecyclable residues (NaCl, Cd, etc.). Questions regarding immobilization processes of salt residues were given tentatively acceptable answers (sodalite solidification of NaCl; Pb-Cd embedment).

In summary, great technological efforts needed to be made in order to consider pyrometallurgy as a viable option for multi-recycling of fuel and target materials.

An overview was also provided, by I.V. Mukhin, of the R&D work going on in Russia in the partitioning field. This would certainly lead to improve contacts with Russian colleagues.

Concerning international co-operation, task distribution should be performed according to available means and resources in order to avoid duplication. It would be worth trying to recontact colleagues in the United states to resume collaboration.

The future tasks could be summarised as follows:

- Investigate the link between spent LWR-MOX and P&T operations.
- Bridge the gap between the waste management and P&T communities.
- Furher investigate the recycling technologies of very hot fuels and targets. Study the limits of the aqueous processing.
- Start performing strategic studies of P&T in the general context of nuclear development.