PARTITIONING AND TRANSMUTATION - TECHNICAL FEASIBILITY, PROLIFERATION RESISTANCE AND SAFEGUARDABILITY

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The advantages of partitioning and transmutation (P&T) of minor actinides and selected fission products are largely discussed and described in literature. The advantages of separation of the long-lived alpha-emitters for the long-term storage of highly radioactive waste have been highlighted. After separation, these nuclides shall be transmuted by means of a dedicated reactor or accelerator driven system into shorter-lived fission products that are less hazardous. This, however, requires the development and implementation of a P&T fuel cycle, involving chemical separation of the minor actinides and the fabrication of MA containing fuels or targets. Concepts for P&T fuel cycles have been developed and technical issues are being addressed in various research programs.

With the recognition of the proliferation potential associated with the minor actinides by the IAEA, also the proliferation and safeguards aspects need to be addressed. It is important to raise these points at an early stage of process development, in order to identify potential problems and to develop appropriate solutions.

The oxide fuels used worldwide in thermal reactor systems for energy production are reprocessed by aqueous techniques. Therefore these systems, primarily the PUREX process, are fully developed and implemented commercially. Furthermore, the safeguards approach is fully implemented in existing facilities, covering uranium and plutonium. Pyroprocess systems have largely been associated with fast reactors and metallic fuels and their development has therefore only reached the pilot-scale stage and the feasibility of minor actinide (MA) separation still needs to be demonstrated. Hydrometallurgical and pyrochemical reprocessing should however not be considered as competing but rather as complementary technologies. For instance in a so-called double strata concept (foreseen for instance in the Japanese OMEGA project), the PUREX process (first stratum) would be combined with a transmutation cycle (second stratum). Here, the first separation of radiotoxic elements from the PUREX high-level liquid waste could be achieved by advanced aqueous partitioning. In the following transmutation cycle, pyroreprocessing should be used, because of a number of advantages; those are

a higher compactness of equipment and the possibility to form an integrated system between irradiation and reprocessing facility (reduced transport of nuclear materials and process costs in general)

higher radiation stability of the salt in the pyrochemical process compared to the organic solvent in the hydrochemical process offers an important advantage when dealing with highly active spent MA fuel

compared with aqueous methods, dry reprocessing results in less pure and thus more proliferation resistant fractions of Pu, Np and Am.

In particular the latter aspect is important in view of the attractiveness of products for proliferation.

In the paper the different partitioning processes, aqueous and dry, will be briefly described and analyzed for their strengths and weaknesses in view of safeguards and proliferation.

Furthermore, the advantages and drawbacks of homogeneous and heterogeneous cycles will be discussed in view of proliferation resistance and safeguardability.