SESSION II

The Nuclear Fuel Cycle and P&T

Chairs: J. Bresee (DOE) – J.P. Schapira (CNRS)

SUMMARY

The introduction by L.H. Baetslé and P. Wydler to this session gave a general overview of new partitioning and transmutation (P&T) fuel cycles based on present technologies (LWR, FR, uranium-plutonium fuels) altogether with their main issues. In order to minimise back end risks, plutonium management has to be addressed first. On the other hand, any P&T fuel cycle assessment has to take into account all the wastes and nuclear materials involved as well as their global impact (radiological, heat, secondary solid wastes, liquid and gaseous effluents). P&T strategy based on multirecycle in FRs leads to a waste radiotoxicity reduction factor of about 3 to 10 (depending on the date) if only plutonium is recycled and of about 100 if all the TRU are recycled within different scenarios (double strata, double components). These figures do not take into account the fuel cycle inventory radiotoxicity. They are strong constraints related to safety coefficients degradation (this can be alleviated by using sub-criticality), to neutron economy and to performances (inventory, burn-up achievable, losses). This paper shows that a factor 100 of mass reduction for TRU can be achieved if losses are less than 0.18% and burn-up greater than 15%, which are real challenges. In this respect, the normal PUREX process might be inadequate. Finally, new options such as pyrochemistry and the use of sub-criticality with accelerator driven systems, which allow the use of fertile free fuels, will probably be needed to achieve such performances. A comprehensive view of the principal actinide transmutation strategies is given using evolutionary and innovative approaches and according to the principal driving force: resource, waste, and proliferation. Concerning long-lived fission products, such as ^{129}I, ^{99}Tc, ^{135}Cs, ^{93}Zr and ^{126}Sn, this paper gives a good review of the various difficulties to include them in a P&T strategy (if chemically separated, most of them might be embedded in a more stable matrix than glass). Finally, the impacts of various P&T options on geological disposal are described.

The other papers describe some work related to P&T carried out in various laboratories as well as a new proposal. In the T. Osugi *et al.* paper, some recent results related to the JAERI double strata strategy are given: nitrides fuels, pyrochemical processes, 800 MW_{th} ADS Pb-Bi target and coolant. Technical issues related to ADS will be studied using the experimental facility at KEK, with the prospect for commercial ADS around 2035. A 800 MW_{th} ADS based on the lead coolant, Rubbia's concept (but with forced convection) is studied at CIEMAT in Spain, with the emphasis on new types of fuel (thorium and nitride inert matrix) applied to TRU burning in LWR (normal MOX fuel) then in ADS.

W. Forsberg proposes to reduce the high-level waste heat loading by chemically separating five heat generating nuclei: Cs, Sr (both to be put in an interim storage for heat decay) Pu, Am and Cm (to be transmuted by P&T). The remnant wastes containing the low-heat radionuclides will be geologically disposed at low cost (no interim storage and reduced disposal surface needed).

H. Boussier *et al.* calculates the potential risk of geological disposal within various P&T scenarios described in the overview paper. The originality of this paper is to consider not the global inventory radiotoxicity but that of the quantities which escapes from the waste deduced from the matrix fraction subjected to alteration over time. However, the difficulty is to get accurate values for such fractions.

The session ended up with the presentation by J. Vergnes *et al.* from EdF of a new concept of a molten salt fuel critical and thermal reactor which is able to produce energy with a very low amount of long lived wastes. In such a reactor called AMSTER (Actinides Molten Salt Transmuter) actinides are recycled, fission products and eventually ^{236}U continuously extracted. At equilibrium and in a fissile isogenerating mode, only fertile material (natural uranium or thorium) is fed into the reactor. AMSTER can incinerate TRU produced in PWR or recycle its own actinides only. First theoretical studies show that a reduction by several decades in the TRU quantities is expected, leading to a “clean energy” reactor, especially if the thorium fuel cycle is used.