

SESSION IV

Basic Physics, Materials and Fuels

Chairs: S. Pilate (BN) – H. Takano (JAERI)

SUMMARY

Session IV was subdivided into three parts devoted respectively to basic physics, materials, fuels and targets.

1. Basic physics

Nuclear data measurements performed or supported by JNC in Japan concern fission and capture cross-sections for Am, Np and long-lived fission product nuclides. In the case of ^{99}Tc , activation measurements revealed significantly different from previous results. It was noted that a co-operation with ORNL is planned.

Residue production in spallation reactions is being studied by researchers from Spain, Germany and France. New experiments are made at Saturne and NESSI (GSI) to identify the numerous isotopes created; an accuracy of 10% on their production is aimed at.

The experimental programme MUSE in MASURCA at CEA-Cadarache, launched in 1995, now continues with 16 different partners and with EC funding. In the present MUSE-4 configuration, a strong pulsed neutron source is fed from the coupled accelerator GENEPI. The k-value will progressively be decreased to 0.95. After the Na-cooled core, a gas-cooled core will be mocked-up.

In parallel, a complementary programme SAD will be run at Dubna (RF), using real spallation sources produced by a synchrotron.

A simplified version of MUSE-4 in RZ geometry is also proposed as a benchmark; the calculations already available indicate differences of e.g. 0.8% on the k-level.

Results of ADS benchmark calculations have been gathered by OECD/NEA and PSI/CEA. NEA had already organised a first, preliminary ADS exercise in 1994. This follow-up exercise started in 1999. Pb-Bi is retained as ADS target and reactor coolant. Two cores are considered: at start-up and at equilibrium. The external source is pre-defined. Significant discrepancies can be observed among the 7 solutions, obtained with the 3 basic data files ENDF/B-VI, JEF 2.2 and JENDL 3.2. The k-values differ by as much as 3% dk, and this is not only an effect of basic data libraries.

A next exercise is planned on a transient ADS benchmark (beam trip). It was pointed out that the partners should give more details on their data processing.

2. Materials

The corrosion of stainless steels in a Pb-Bi circuit has been studied by CIEMAT for temperatures ranging from 400°C (cold leg) to 550°C (hot leg). The loop was made of austenitic steel while test samples were made of 2 martensitic steels. The oxide layer formation was recorded after different operation times up to 3 000 hours. A gas with 10 ppm O₂ was bubbling in the hot leg.

The oxide protection layer grew with time. The coolant dissolved some elements of the steel, mainly nickel.

Such experiments, crucial for the use of Pb-Bi coolants, should be made again, provided the exact O₂ activity be well monitored.

Two other papers were devoted:

- A Russian one, to the production of residues from spallation (as above).
- A Korean one, to thermal and stress analysis for the HYPER target; HYPER is the accelerator driven system developed by KAERI, based on the use of Pb-Bi coolant (another KAERI paper also considered the problem of transmuting ⁹⁹Tc and ¹²⁹I in HYPER, what is very difficult).

3. Fuels and targets

While a paper by industrial companies stressed the interest to develop practical concepts of Am targets, to be placed in special, moderated positions in fast reactor cores, two very interesting papers by ITU and CEA described the experimental programmes devoted to new fuels and targets in Europe. Both are complementary, and the EC sponsorship stimulates a vast European collaboration.

Different promising concepts will be examined and tested, as for example IMMOX (Inert Matrix MOX), THOMOX (where ThO₂ is a “quasi-inert matrix”), MATINA (with macromasses instead of micro-dispersion), ECRIX/CAMIX/COCHIX to be loaded in Phénix.

Two laboratories for minor actinides have recently been built in Europe, the one at Marcoule (ATALANTE) and the other one at ITU Karlsruhe, allowing handling Am in the kg range.

In Japan, JAERI also builds a new facility TRU-HITEC, for high-temperature chemistry of Am and Cm. Available at Tokai in 2002, it will allow to handle dozens of grams of Am and Np, in addition to Pu. The research is centered there on nitride fuel with inert matrix, and on pyro-processing (as described in a JAERI paper on ADS transmutation in Session V).

The set-up of these three laboratories for minor actinides handling is a concrete result of the “decade of revival” for transmutation research, which had been illustrated in the bright overview paper introducing Session IV, given by Mr. M. Salvatores.

The coming decade should now help identify the most efficient transmutation options thanks to irradiation experiments.