TECHNICAL SESSION III – SUMMARY
Progress in Fuels and Targets

Yasuo Arai (JAERI, Japan) and Sylvie Pillon (CEA, France)

Papers presented:

Papers covered research areas from fuel preparation and basic properties, fabrication processes, irradiation program to design and modelling calculation.

Papers covered chemical forms from alloy, inter-metallic dispersion, oxide (pellets, VIPAC), nitride, molten salt to FP target (Tc and I).

Russia	2
USA	1
Netherlands	2
France	3
Japan	2
Korea	2
Total	**12**

Highlight of preparation and basic research

Akabori et al. (JAERI, Japan)

- Preparation of oxide-free (Am,Zr)N and (Am,Y)N by carbothermic reduction.
- Thermal property (thermal expansion, specific heat) of Tc-Ru alloy.
- Preparation and compatibility test of CuI and $Ca(IO_3)_2$.
- Construction of new facility TRU-HITEC for gram-order test of ^{241}Am.

Ignatiev et al. (RRC-KI, Russia)

- Transport properties of Na,Li,Be/F and Li,Be,Th/F for MSB (Molten-salt Burner Reactor).
- Viscosity, thermal conductivity, phase transition behaviour, heat capacity, density and thermal expansion.
- Comparison of obtained data with previous ones, such as obtained in ORNL.

Highlight of irradiation test program

N. Schmidt et al. (CEA, France)

- Transmutation of MA-targets in FR (high neutron flux), but in spectrum locally moderated.
- Sample preparation and modelling calculation before start of irradiation (Phenix).
- ECRIX: AmO_X micro-dispersed in MgO.
- CAMIX n°1: (Am-YSZ) solid solution.
- CAMIX n°2: (Am-YSZ) micro-dispersed in MgO.
- COCHIX n°3: (Am-YSZ) macro-dispersed in MgO.

Y. Arai et al. (JAERI, Japan)

- Start of irradiation test of (Pu,Zr)N and PuN+TiN at JMTR.
- Preliminary results of PIEs of (U,Pu)N irradiated at JOYO.
- Progress of pyrochemical process for treatment of MA fuel.

F.C. Klaassen et al. (NRG, Netherlands)

- Speculation from extensive irradiation tests of $MgAl_2O_4$ -IMF at HFR.
- EFTTRA (for incineration of Am) and OTTO (for Pu).
- Its chemical property and thermal conductivity are good, but
  - large volumetric swelling is observed : amorphisation and He production;
  - instability under irradiation makes very doubtful.

S. Pillon et al. (CEA, France)

- From the THERMHET in Siloe and MATINA1 in Phenix: $MgAl_2O_4$ swells at T < 1 200°C by amorphisation : abandon.
- MgO is the reference inert matrix: T5, MATINA 2/3, CAMIX-COCHIX.
- Irradiation project of different dedicated fuels (nitride/metal/oxide) in Phenix.

R. Schram et al. (NRG, Netherlands)

- Results of irradiation tests of $MgAl_2O_4$ + 11 wt% AmO_2.
  ==> significant swelling (He, amorphisation).
- New ideas: He should be released from the target in early stage of irradiation: porosity control, increasing Pu content to raise temperature.
- New candidates: (Am, (Pu) Zr, Y)O_2, $Am(Pu)_2Zr_2O_7$, (Am, Zr, Y)O_2 +metal or MgO.

O. Shishalov et al. (RIAR, Russia)

- Synthesis by pyroelectrochemistry of (U, Np)O_2 / 5% NpO_2).
- Granulation and vibropacking.
- Irradiation in BOR-60 (2 pins)
  - BU>13.7 at%
  - BU>20 at%.
- Very good behaviour, similar to UO_2 and (U, Pu)O_2.

Highlight of design and modelling calculation

J. Laidler (ANL, USA)

- Function and required fuel performance described.
- Long-term development program:
  - Phase 1: Screening and selection of fuel (completed)
    ==> metal and nitride.
  - Phase 2: Concept definition and feasibility (started), including irradiation examinations.
  - Phase 3: Design, implement and evaluation.
  - Phase 4: Fuel qualification and demonstration.

Lee et al. (KAERI, Korea)

- Modelling of alloy fuel (TRU-Zr and U-TRU-Zr) and inter-metallic dispersion fuel ((TRU-Zr)-Zr and (U-TRU-Zr)-Zr) performance at HYPER.
- Temperature profile, swelling/FGR behaviour (with and without contribution of He) and cladding (HT-9) deformation calculation at burn-up progressing.
- Preliminary design of the fuel rod and burn-up limit under several conditions are evaluated.

S. Pillon et al. (CEA, France)

- Design of moderated assembly for once-through strategy.

Highlight of fabrication study

S. Pillon (CEA, France)

- Proposal of flowsheet for fabrication of (Am,Cm)O_2+MgO target after partitioning process to assembly mounting stage in technological scale.

- But technical feasibility of the fabrication process is far from demonstration stage, because of high decay heat and neutron emission mainly from Cm.
- Innovative processes for remote handling and hot cells are requested (simple, robust, compact and dust free processes): sol-gel/infiltration (ITU), VIPAC (RIAR).

B-S. Lee (KAERI, Korea)

- Dispersion type (U-10%Zr)-Zr and alloy-type U-Zr fuels were fabricated and characterised.
- A centrifugal atomisation method was adopted for fabrication of metal and alloys particles.

Conclusions (progress since last meeting)

- Completion of the PIE irradiation tests (T4, MATINA1, THERMET, RIAR programmes)
  - $MgAl_2O_4$ is abandoned, MgO is still the reference matrix;
  - Macrodispersed fuel is promising for the high BU objective;
  - VIPAC (U, Pu, Np)O_2 fuel runs very well as (U, Pu)O_2.
- New irradiation tests for transmutation are carrying out and planned
  - T5 for new concepts testing (Pu-based target, porous targets, optimised actinide compounds);
  - CAMIX-COCHIX (optimised actinide compounds, microstructure);
  - FUTURIX (comparison of different TRU fuels in representative and similar conditions).
- Experimental study on fuel containing Am has proceeded for a few years, although still in a laboratory scale.
- However, there are still open questions:
  - Behaviour of He during irradiation: preference for releasing it (high temperature operating, porous fuel).
  - Selection of inert matrices: $MgAl_2O_4$ dropped, still MgO (to be proved), metallic matrices: steel, Mo?
  - Chemical form for transmutation of ^{129}I.
  - Processing with Cm: VIPAC/SPHEREPAC.
- Metallic fuel vs ceramic fuel (nitride, oxide).
- International collaboration is essential for further development. Effective usage of fabrication facility (inauguration of MA-lab, ITU), reactor (restart of Phenix, beginning of 2003), PIE facility and compilation of previous data.
