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PHYSOR 2008 Conference Wrap-up on Advanced Systems

Presented at
International Conference on the Physics of Reactors "Nuclear Power: A Sustainable Resource," Interlaken, Switzerland
September 14-19, 2008

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Overview

- **Advanced Systems issues were covered in papers presented in five different tracks**
  - Track 5: Advanced Fuel & Core Design
  - Track 8: Actinide Management
  - Track 9: Fast Reactor Design & Safety
  - Track 13: Fuel & Materials Behavior
  - Track 16: Nuclear Power & Sustainable Development
- **Few papers only will be highlighted**

Track 5: Advanced Fuel & Core Design

- **Covered variety of fuel and core design issues for LWRs and HWR, and various advanced concepts**
  - Advanced systems including Gen IV VHTR, MSR and SCWR
  - Increased sustainability (e.g. H_2 production)
- **Paper by E. Kulikov, on "Neutronics of super-critical LWR lattice with (Th+U)O2-fuel: how to suppress coolant effect of reactivity"**
  - Proposed adding small amount of Am-241 to fuel to reduce the coolant temperature reactivity coefficient (TRC) and demonstrated its effectiveness
- **"Fuel cycle flexibility of ACR-1000," by M. Ovanes et al**
  - Unique combination of fuel bundle design and on-power fueling, and different fueling schemes enables operation with LEU, MOX and Th fuels
  - No major changes to reactor core control and safety systems
  - All reactivity feedback coefficients are moderately negative
  - Overall safety case remains consistent

Track 8: Actinide Management

- **Addressed diverse solutions for managing Pu and minor actinides (MAs)**
  - Mostly on MA-transmutation options in ADS, and fast and thermal reactors
  - Some assessed impacts on fuel-cycle technologies – a crucial aspect meriting greater attention from implementation viewpoint
- **"Heterogeneous Recycle of Transuranics Fuels in Fast Reactors," by Hoffman et al**
  - Neutronics of homogeneous and heterogeneous recycle cores quite similar
  - Major differences arise in other parts of fuel cycle – e.g., handling highly radioactive targets or ability to start-up transmutation campaign with MA-containing fuels
  - Modified homogenous recycle approach as an option to heterogeneous recycle
- **R. J. Fetterman, "AP1000 core design with 50% MOX loading" demonstrated compliance with EUR requirement for MOX utilization**
- **"Preliminary core design of the European lead-cooled system," by Malambu, et al**
  - Start-up core based on MOX-fuel assembly design and a 2$-reactivity excess, can operate for 3 ½ years, reaching a peak burnup of about 60 GWd/tHM
  - At higher burnup, pellet-cladding mechanical interaction (PCMI) would occur, requiring further fuel design optimization

Track 9: Fast Reactor Design & Safety

- **Gen IV SFR, GFR, and LFR advanced core concepts, reactor and plant designs, and advanced safety evaluations using modern simulation tools and models**
  - Two sessions each for papers on GFR and SFR/LFR
- **Richard et al, "Status of the pre-conceptual design studies of the GFR core"**
  - Reference "high temperature" GFR, uses plate-type fuel in honeycomb structure containing cylindrical pellets made of (U,Pu)C and a ceramic cladding (SiC/SiCf)
  - Two alternative cores: (1) "high temperature" pin-type core with ceramic cladding (SiC/SiC); (2) "low temperature" plate-type core with metallic (ODS) cladding
- **"GIF GFR end-of-exploratory phase design and safety studies," by J. Y. Malo et al**
- **"Comparative transient analysis of the 2400MWth GFR with the TRACE and CATHARE codes," by A. Epiney et al**
- **C. Poette at al., on "ETDR, The European Union's Experimental Gas-Cooled Fast Reactor Project"; status and plans of the international collaboration**
- **T. Kim et al., "Core design studies for a 1000 MWth advanced burner reactor"**
  - Variable CR (0.2 to ~1) for metallic and oxide cores meeting design specifications
- **Rimpault et al., "Towards GEN IV SFR design: Promising ideas for large advanced SFR Core Designs"**
  - Indicated advantages of carbide fuel compared to oxide fuel, but requires R&D
- **"Flexible conversion ratio lead cooled reactor design," by E. Shwageraus et al**

Track 13: Fuel & Materials Behavior

- **Papers mainly of two types**
  - Behavior of fuels in existing LWRs during accident scenarios (RIA and LOCA), providing original experimental results and interpretations
  - Other papers on model and fuel development issues, for operating and future nuclear systems
- **L.J. Ott et al, "Summary of irradiation tests of mixed oxide fuel prepared with weapons-derived plutonium"**
- **Two papers on TRISO Fuel**
  - "Relative release-to-birth indicators for investigating TRISO fuel fission gas release models," by Harp et al
  - "Development of a stress analysis code for TRISO particles in HTRs," Jonnet et al

Track 16: Nuclear Power & Sustainable Development

- **Various sustainability aspects of nuclear power were addressed**
  - Three elements of sustainability covered: environmental, economic and social
  - Specific topics: uranium resources; economics of various fuel cycle options; human resource needs; perspectives on sustainability from industrialized and developing countries; and comparative, indicator-based sustainability assessment of nuclear, fossil and renewable energy sources
- **S. Hirschberg, "Nuclear energy risks and benefits in perspective"**
  - Recent trends towards nuclear systems designs preventing severe accidents (reliance on passive safety) and reducing waste confinement times
  - No guarantees that sustainability of nuclear energy will be generally acknowledged, even if such developments are implemented
  - However, such implementation allows favorable comparison against social criteria
- **"Achieving sustainability in fuel cycles with Th-fuelled thermal Breeders," by K. Tu.ek et al**
  - By end of 21st century, PWRs and FRs could generate enough U-233 to sustain an increase in nuclear power capacities to 1160 GWe (x3) worldwide
  - In later centuries, transuranic elements in fuel cycle will decrease and stabilize
  - Reprocessing and remote fabrication technologies and non-proliferations needs