OECD/NEA 11th Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation

OECD/NEA activities related to Partitioning and Transmutation

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OECD Nuclear Energy Agency (NEA)

- Founded in 1958 (currently 28 member countries, + ..)
  - A semi-autonomous agency of the OECD
- Forum for promoting international co-operation
  - Homogeneous membership (developed countries)
- Focus on scientific, technical, strategic and legal work
  - 7 standing technical committees, ~70 working parties & expert groups
  - Flexibility
- Also Technical Secretariat of GIF and MDEP

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OECD/NEA activities related to P&T

- Fuel cycle transition scenarios
- Trends in the nuclear fuel cycle
- Benefits and impact of advanced fuel cycles with P&T
- Fuels and materials
- Fuel cycle chemistry
- Integral experiments for minor actinide management
- Peer review (MYRRHA)
- Conferences and workshops

*These activities are conducted by the NSC (Nuclear Science Committee) and the NDC (Nuclear Development Committee)*
Fuel cycle transition scenarios

- **Objective**
  - Study of transition scenarios from current to FR
  - Discuss related scientific and strategic/policy issues
  - Identify R&D needs for fast system deployment

- **Published**
  - Status report on fuel cycle transition scenarios (2009)
  - Regional study on potential European fuel cycle transition (2009)
  - Strategic and policy issues raised by the transition from thermal to fast nuclear systems (2009)

- **On-going**
  - Benchmark of scenario codes (finalised)
  - Global scenario study (final stage)
Benchmark of transition scenario codes

Objective
- Compare existing scenario codes in term of capabilities, modelling methods and results

Two phases
- Phase 1 – Depletion calculation;
- Phase 2 – Transition calculation

Three scenarios
- 1. Once through;
- 2. Limited Pu recycling in LWRs;
- 3. Pu and MA recycling in FR

Codes from Belgium, Canada, France, Germany, Italy, Japan, Spain and USA participate

More info: Session 1 - Lionel Boucher (CEA)
Global transition scenarios

- **Objectives**
  - Study a world transition scenario towards fast reactors
  - Investigation of both homogeneous and heterogeneous scenarios

- **Topics**
  - Uranium resource demand
  - Reactor build rates
  - Back end
    - Used fuel discharged as a function of time
    - Composition and radiotoxicity
  - Infrastructure requirements as a function of time
  - Selected sensitivity studies (includes LWR only case for comparison)

- **More info:** Session 1 – A. Schwenk-Ferrero (KIT)
Trends in the nuclear fuel cycle

- **Objective**

- **Scope**
  - *Investigate developments in the NFC and analyse trends*
    - Over the past decade / in the future
    - In the technical development of NFC / with respect to sustainability goals / nationally and internationally
  - *Analyse the sustainability elements of NFCs*
    - Economic (cost, optimise use of resources)
    - Social (enhance safety, proliferation resistance)
    - Environment (reduce impacts)
  - *Focus on policy and strategies*
    - Review experience and perspectives in policy making
    - Provide a strong technical basis

- **To be published by the end of 2011**
Potential benefits and impact of advanced fuel cycles with P&T

- **Objectives**
  - Analyse various studies on the impact of P&T on geological disposals, to identify common conclusions and the need for future work based on various advanced fuel cycles
  - Assess the impact on geological repository characteristics and make recommendations on appropriate criteria to evaluate the impact of P&T based on the level of losses during fuel re-processing

- **Recent studies show**
  - *Evolution of the role of P&T*
    - P&T is not longer considered as a stand alone option
  - *Option can be integrated in advanced fuel cycles*
    - Increase sustainability, efficient use of U resources, waste minimisation, higher economics, safety and proliferation resistance (e.g. Gen-IV)

- **Final review in progress**
Potential benefits and impact of advanced fuel cycles with P&T (main findings)

- Impact on geological disposal
  - Possible reduction of heat load, radiotoxicity and dose

- P&T and geological disposal
  - For existing reprocessed waste: no impact
  - For existing spent fuel: impact depends on
    - National strategies on nuclear industry (phase-out/reprocessing)
    - Transition scenarios / delay in deployment of FR
  - For advanced fuel cycles with P&T
    - Possible implementation in some countries in 30 years (France, Japan, Russia, China, ...)
    - Anyway, geological disposal will be still needed for long-lived fission and activation products + actinide losses

- More info: Session II - R. Wigeland (INL)
Fuels and materials

- **Objectives**
  - Update information on fuels and materials for implementing advanced nuclear fuel cycles
  - Evaluation of innovative fuels and materials technologies, including fabrication processes and performances
  - Study heavy liquid metal (HLM) technology

- **Output**
  - Status report on innovative fuels (on-going)
  - Status report on innovative structure materials (final stage)
  - LBE Handbook (update on-going)
  - Thermal hydraulic characteristics of LBE (on-going)
Innovative fuels

- **Objectives**
  - Study technical issues associated with the development of innovative fuels, mostly minor actinide contained fuels and clad materials, targeted for use in advanced fuel cycles
  - Establish a innovative fuels database

- **Status report**
  - Metal, oxide, nitride, dispersion fuels (CERCER, CERMET), special mechanic fuel forms (Sphere-pac, Vibro-pac, Particle fuels)
  - Field of interest
    - Fabrication, characterisation and irradiation performance, Safety characteristics, Design and safety criteria, System dependency - Cladding materials, Technical readiness level

- **First draft by the end of 2010**
- **More info: Session 3**
Innovative structure materials

- Objectives
  - Study innovative structural materials under extreme conditions such as high temperature, high dose rate and corrosive chemical environment and long service lifetime
  - Establish a innovative structure material database

- Status report
  - Current R&D status on structure materials for Gen-IV and ADS
  - Contribution from Belgium, France, Germany, Italy, Japan, Korea, Switzerland, Spain, UK, USA

- Final review in progress
Chemical partitioning

- Objectives
  - Technical assessments of various separations processes
  - Develop a scientific basis of nuclear waste recycle
  - Study nuclear data for radioactive waste management

- Output
  - National programmes in chemical partitioning (published in 2010)
  - Flowsheet studies (finalised)
  - Curium management (finalised)
  - Progress in separation chemistry and future R&D (on-going)
Separation chemistry

- Update status of reprocessing technologies

- Scope of the study
  - Progress of separation technology and current achievement
    - Hydrometallurgy,
    - Pyrometallurgy: metal and oxide electro-refining
    - Other process - Fluoride volatility, FLUREX
    - Head-end processes
  - Separation requirements from the viewpoint of fuel cycle scenario
  - Perspective of future R&D

- First draft by the end 2010
- More info: see papers in Session IV
Integral experiments for minor actinide (MA) management

- Objectives
  - Review of nuclear data and target accuracy required for MA management and of existing integral data
  - Request and priority list of nuclear reactions/events, energy range and measurement error

- Scope of the study
  - Identify current issued and required experiments specification for optimal MA management
  - Evaluate availability of existing experimental facilities and need of new facility development
  - Establish secure route of supplying MA samples
  - Improvement of experimental technique
  - Foster international cooperation

- 9 partners (Be, Ch, De, Fr, It, Jp, Ko, RF, US)

- First draft report by end 2011
International Peer Review of the MYRRHA Project

- International peer-reviews are part of the NEA activities (at the request of member countries govts)
- MYRRHA: an accelerator driven lead-bismuth eutectic cooled sub-critical reactor
- Review team of 7 high-level experts from 7 different countries
- Report published at the end of 2009
- Main recommendation endorsed by the Belgian government
  - Further phase ("Risk reduction and allocation before proceeding to construction")
- Belgian gvt will fund 40% if marks of interest of potential investors transformed in hard commitments
Conferences and workshops

- Technology and components of ADS (TCADS)
- Structural materials for innovative nuclear systems (SMINS)
- Actinides and fission product partitioning and transmutation (IEMPT)
Workshop on technology and components of ADS (TCADS-1)

- 15-17 Mar 2010, Karlsruhe, Germany hosted by KIT
  - ~70 presentations, ~100 participants from 18 member countries, IAEA, CERN, EC

Scope
- R&D status of ADS, including accelerators
- Neutron sources and sub-critical systems for current facilities, as well as future experimental and power systems
- Technology, engineering and research aspects of the above components
- System optimisation for reducing capital and operational costs
- Role of ADS in advanced fuel cycles
Main findings of TCADS-1

- Projects around the world are progressing
  - EUROTRANS (EC), MYRRHA (Belgium), J-PARC (Japan), SNS (USA), MEGAPIE (Switzerland)

- Improved technologies
  - Beam stability, Windowless target, spallation sources, materials

- Increase of sub-critical system designs
  - Fuel cycle issues, fuels and materials, system analysis

- Innovative ADS
  - ADS with Th fuels, Am/Cm burner

- Proceedings are under preparation
2\textsuperscript{nd} workshop on structural materials for innovative nuclear systems (SMINS-2)

- **Hosted by KAERI, Daejon, Korea, 31 Aug- 3 Sep 2010**
  - ~80 presentations, ~100 participants from 15 countries and IAEA

- **Scope**
  - Fundamental studies, modelling and experiments on innovative structure materials including cladding materials for the range of advanced nuclear systems such as thermal/fast systems, sub-critical systems, as well as fusion systems

- **Topics**
  - Fundamental studies; Metallic materials; Ceramic materials; Novel materials pathways

- **Plenary talks and round table discussions organised**
Main findings of SMINS-2

- Summary session: “Critical experiments, modelling needs and round robin opportunities”
  - Issues for innovative structure materials were identified
  - Technical readiness level (TRL) could be a proper tool to evaluate current R&D level
  - International data base on structural materials for innovative nuclear system is needed
  - Further collaboration with material scientists in non-nuclear field is needed
  - SMINS workshop should be continued covering both the modelling and measurement community

- Proceedings are under preparation
Information Exchange Meetings on Actinide and Fission Product P&T (IEMPT)

- Forum for discussing scientific and strategic developments in the field of P&T (since 1990)

- Mito (Japan) 1990
- ANL (USA) 1992
- Cadarache (France) 1994
- Mito (Japan) 1996
- Mol (Belgium) 1998
- Madrid (Spain) 2000
- Jeju (Korea) 2002
- Las Vegas (USA) 2004
- Nimes (France) 2006
- Mito (Japan) 2008
- San Francisco (USA) 2010
- Prague (Czech Rep.) 2012

Number of papers
Papers by session at the 11th IEMPT

- **Oral presentation**
- **Poster**

Opening: National programmes on P&T
S-I: Fuel cycle strategies and transition scenarios
S-II: Waste forms and geological disposal
S-III: Transmutation fuels and targets
S-IV: Pyro and aqueous separation processes
S-V: Transmutation physics and materials
S-VI: Transmutation systems: design, performance and safety
Concluding Remarks

- Numerous and various NEA activities related to P&T
  - Covering both scientific and strategic aspects
- Main activities in the areas of
  - Transition scenarios, fuels and materials, and fuel cycle chemistry
- Increased interest noted in
  - Thorium cycle, nuclear fuel “deep burn”
  - Economics

- A lively P&T community
- Large number of options considered
- Need to consider industry views