Sustainability of advanced fuel cycles

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Features of Sustainability

- Minimisation of fuel fabrication & reprocessing by enhancing burn-up
- Minimisation of waste volume
- Reduced toxicity of waste
- Enhanced safety in operations
- Economy: operation of fuel cycle facilities at name plate capacity, enhanced plant life
- Reduced exposure to operators

Enhancing burn-up

- MOX, Carbide as well as metallic fuels have been irradiated to 150 GWd/t
- Advanced materials such as ODS show promise of operation up to 200 GWd/t
- The advantages of operating to higher burn-up will need to be weighed against challenges in back end fuel cycle
- Metallic fuel offers better prospects

Separations: Advanced options

- One extractant that can extract minor actinides but not lanthanides
- Extractant that can extract U,Pu and minor actinides together
- Room temperature ionic liquids: enhancing fire safety, avoiding third phase formation..
- Supercritical fluid extraction: no diluents, no secondary wastes..
- Recovery of societally useful fission products

R&D areas: safety

- Extractant-diluent combinations that do not form red oil
  - Low solubility of extractants in aqueous phase
  - Extractants with favorable thermochemical behaviour
- Exposure to operators during fuel fabrication due to powder handling

    - Sol-gel process: challenges

Minor actinides

- Partitioning of minor actinides alone cannot resolve the issue of waste: incineration in fast reactors is important- fuel cycles need to be developed
- Incineration of minor actinides: matrices

Waste matrices

- Fast reactor fuel reprocessing produces high level waste with a different profile of fission products as compared to thermal reactor fuels (eg. Noble metals). The conventional borosilicate glass matrix is not compatible with noble metals, silver..
- New matrices (eg. Synroc, iron phosphate glass) may be required to reduce volume of glass produced per unit energy produced..
- Limited experience in handling FR waste..

Plant life

- The philosophy of design for fuel cycle facilities has to be in line with reactor systems: they have to be operational for same period of time
- Materials technologies (eg. corrosion), inspection technologies, modeling and simulation all need to be addressed in a formalised manner as in case of reactors

Collaborations

- There is a need to enhance international collaborations in the area of nuclear fuel cycle in general, and fast reactor fuel cycle in particular.
- IAEA can play a key role in promoting the collaborations, especially in the area of safety and basic research related to fuel cycle

Thank you