GEN IV International Forum℠
Expertise | Collaboration | Excellence

Closing Nuclear Fuel Cycle

Summary / Objectives:

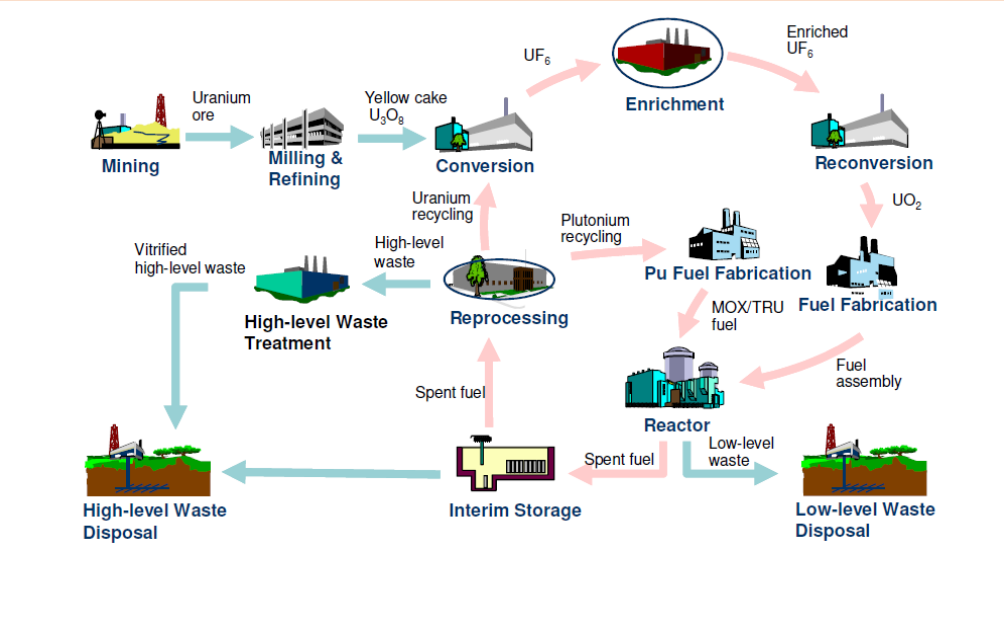
The steps of PWR nuclear fuel cycle along with alternative fuel cycle options are described. The concepts of two methods for closing the fuel cycle, i.e., recovering the residual uranium and plutonium contained in spent fuel for reuse by wet PUREX and dry Pyroprocessing, are explained. The major issues to be considered for closing the fuel cycle are identified to provide an understanding of sustainability and nonproliferation.

Meet the Presenter:

Prof. Myung Seung Yang has been working at KAERI (Korea Atomic Energy Research Institute) for 30 years in R & D on PWR/CANDU fuel fabrication, quality control of fuel, DUPIC (direct use of spent PWR fuels in CANDU) cycle and the pyroprocessing. He gained the experience in nonproliferation through participating in GIF PRPP and INPRO activities. He served as the President of KAERI from 2007 to 2010 and is a member of the National Academy of Engineering of Korea. He is a Professor at Youngsan University since 2015. He received a decoration “Woong-Bee Order” from the Korean government in 2011, and a WNA (World Nuclear Association, London) Award in 2009 for his contribution to the peaceful use of nuclear energy.

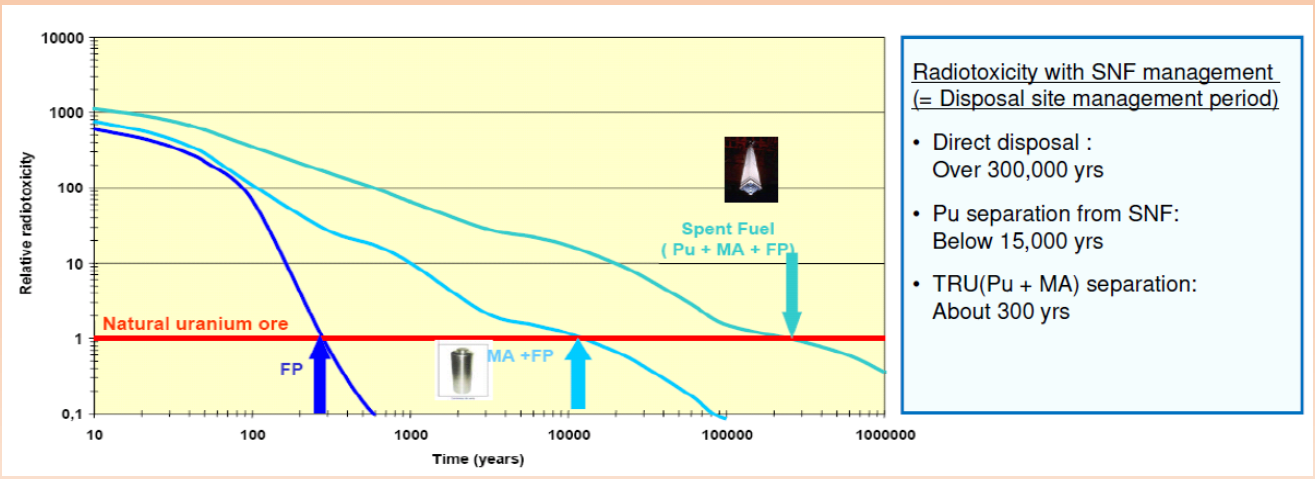
Concept of Nuclear Fuel Cycle

- Reactors are classified according to neutron energy, moderator, coolant, and nuclear fuel.
- Spent fuel (SNF) is recycled or disposed directly (once through) .



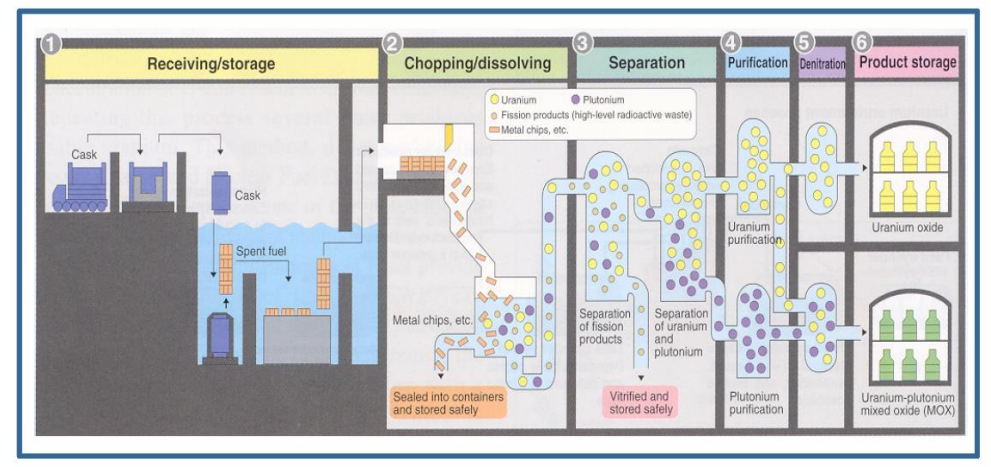
Spent Nuclear Fuel Management

- SNF contains transuranium elements(TRU), fission products(FP) and remaining uranium.
- Most of decay heat after several hundred years are caused by TRU.
- Radiotoxity decreases to natural uranium ore level after 300 years by separation of TRU.
- SNF is stored (wet or dry), packaged, and disposed in underground facility.
- Consideration on corrosion rate of canister etc, are necessary for disposal site.



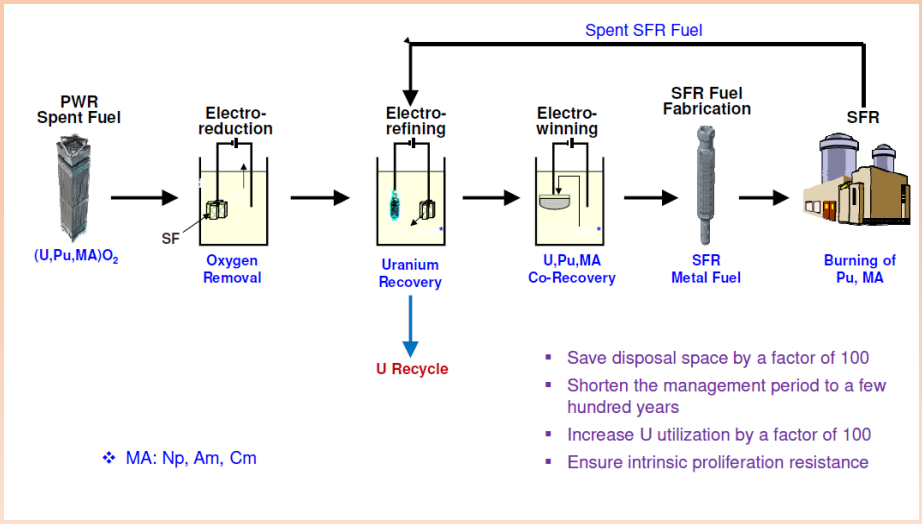
Nuclear Fuel Cycle Technology

- Proliferation resistance, sustainability, waste management, environment effect, and economics are required for innovative nuclear energy system
- PUREX is wet process, and Pyroprocess and DUPIC are dry proceees.
- PUREX process is composed of receiving/storage, chopping/dissolving/, separation, purification, de-nitration, and product storage.
- Advanced wet processes (CoDCon, ALSEP, NEXT, COEX) are under development.



Nuclear Fuel Cycle Technology

- DUPIC and Pyroprocess are appropriate for closed cycle by CANDU, PWR and Gen. IV FR (SFR).
- DUPIC process is composed of disassembling, cutting, de-cladding, oxidation/ reduction, pelletizing/sintering, welding, and assembling.
- There are several dry process technology, such as Pyro-metallurgical, Pyro-chemical, Fluoride volatility.
- Pyroprocess flow sheet is composed of de-cladding, high temperature treatment, electro-reduction, electro-refining, electro-winning, and SFR fuel fabrication.



Nuclear Fuel Cycle Technology

- Pyro-process has merits, such as small number of components, short cooling time, low criticality hazard, and no pure Pu separation.
- Pyro-process has lower proliferation potential due to limited capability in separation Pu, etc, but has several challenges, such as less safeguard experience.
- Safeguard R&D and economic evaluation of nuclear fuel cycle have been continuing.
- Policy for SNF management on several courtiers are compared.

	Korea	USA	Japan	France	Russia	China	India
Fuel Cycle Policy	Wait & See	Direct disposal/ Wait & see (P&T)	Recycle (P&T)	Recycle (P&T)	Recycle (P&T)	Recycle (P&T)	Recycle (P&T)
Target Yr for INS	2020's	2040s	2040s	2020 ~ 2040	2020s	2020s	2020s
Recycle Method	Pyro	Wet (Advanced Aqueous) Pyro	Wet (NEXT) Pyro	Wet (COEX /GANEX)	Wet (Advanced Aqueous) Pyro	Wet (PUREX) Pyro	Wet (PUREX) Pyro
Reactor (Fuel)	SFR (Metal)	SFR (Metal, Oxide)	SFR (Oxide)	SFR (Oxide) GFR (Carbide, Nitride)	SFR (Oxide, Nitride)	SFR (Mixed oxide)	SFR (Mixed carbide, Oxide, Metal)

Summary

- Benefits of closing nuclear fuel cycle are sustainability, management of high level waste, environmental friendly, management of repository for permanent disposal, and enhanced proliferation resistance.
- Advanced wet & dry fuel cycle processes along with safeguards technology are under development.
- National policy of spent fuel management is to be decided.