GEN IV International Forum
Expertise | Collaboration | Excellence

On Thorium As Nuclear Fuel

Summary / Objectives:

This webinar will present an overview of the basic concepts behind the historical interest on the use of thorium as a nuclear fuel. It will aim at reviewing thorium's real potential and the many challenges it is facing before it can be part of the solution to the world's energy problems. It is aimed at giving some of the scientific elements to a general audience in order to "demystify the thorium question" which has regained some prominence in recent years when talking about future nuclear concepts.

Meet the Presenter:

Dr. Franco Michel-Sendis is responsible for the co-ordination of Nuclear Data Services and Criticality Safety Activities at the OECD Nuclear Energy Agency (NEA) under the Data Bank and the Nuclear Science Division, since 2010. From 2011 to 2016 he also served as NEA scientific secretary to the Generation IV Molten Salt Reactor System Steering Committee and coordinated the NEA report "Introduction of Thorium in the Nuclear Fuel Cycle". Dr. Michel-Sendis holds a B.Sc and M.Sc in physics from the University of Paris (UPMC) and a Ph.D. in nuclear reactor physics from the University of Paris-Sud Orsay.

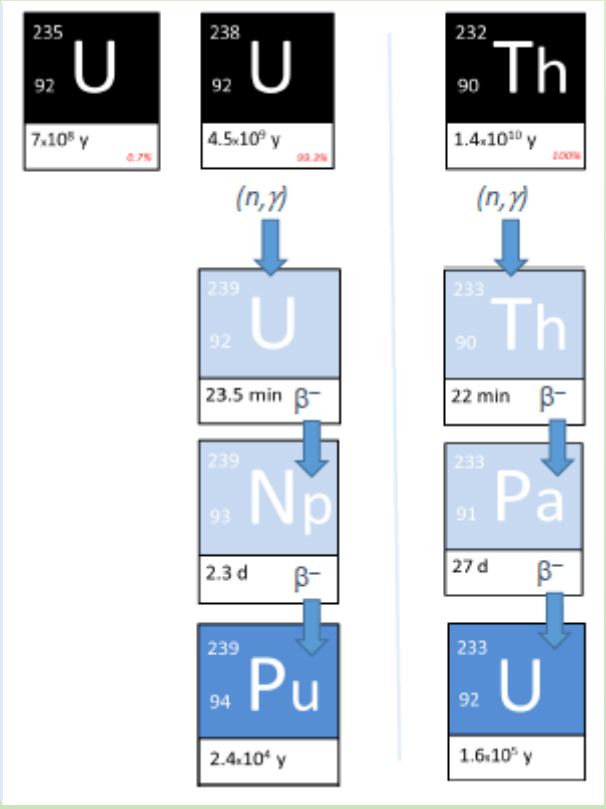
1. U or Th? Not that much of a choice in fact :

- Only three actinides are naturally present on Earth
- Thorium is likely abundant
- But Thorium lacks a fissile isotope; only ^{235}U is fissile

Under neutron irradiation :

- 238U will produce 239Pu
- 232Th will produce 233U

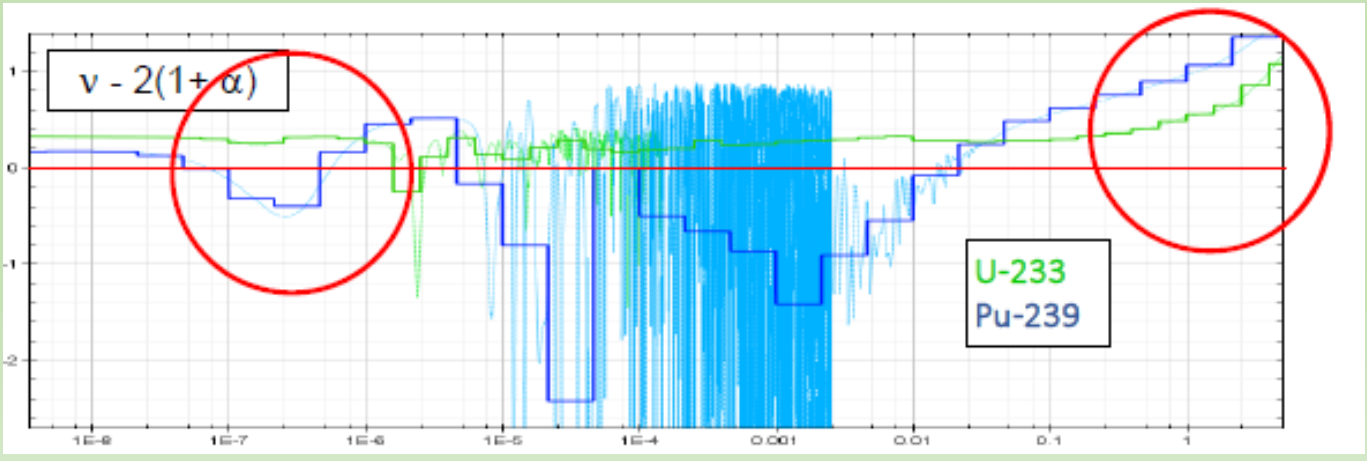
- 232Th excellent fertile
- 233U excellent fissile (in harder neutron spectra)



2. Neutron Economy:

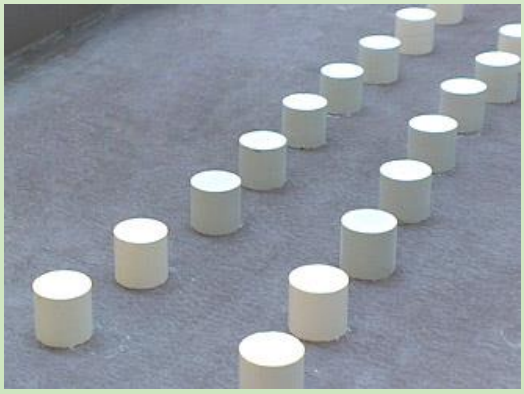
Breeding with Th-U233: possible in thermal spectrum

U/Pu cycle : best neutron economy in fast spectrum



3. Thoria(ThO2)-based fuels (in current technologyies) :

- Thoria-based fuels for LWRs and PHWRs exhibit improved defect performance and are a highly prospective technology for consuming or transmuting transuranic (Pu + MA) nuclides
- Thoria-based fuels must first be qualified to assure their safe performance in the usual suite of normal/accident scenarios; Processes will require significant further development and test programmes to manufacture and qualify optimal industrial thorium-based fuels.

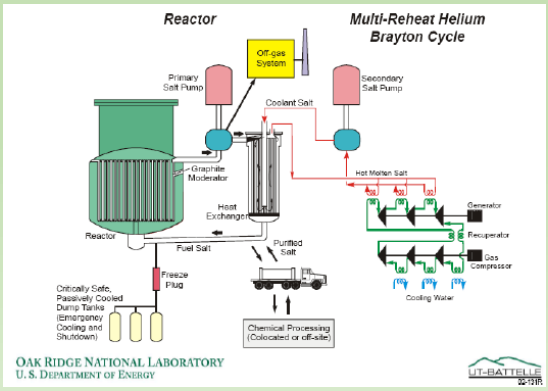


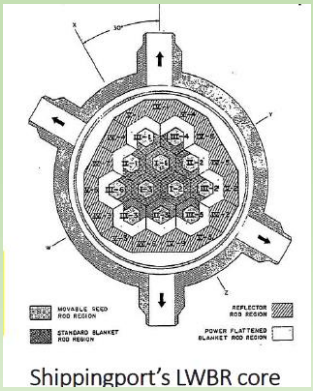
ThorEnergy@ IFE, Norway, (Th, Ce)O_2
Irradiation tests at OECD Halden Reactor

4. Past Experience of Thorium development:

In 1960/70's, some reactors have used Thorium based fuels.

YEAR	Country	Reactor	Type	P (MWe)	Fuel Type	
1962	USA	IndianPoint1	PWR	275	Th/HEU-235	Mixed Oxide
1964-1969	**USA**	**MSRE**	**MSR**	**2-3**	**U-233 FLiBe**	**Molten salt**
1967-1974	USA	Peach Bottom	HTR	40	Th/HEU carbide	Microspheres
1976-1989	USA	Fort St Vrain	HTR	330	Th/HEU carbide	Microspheres
1977-1982	**USA**	**Shippingport**	**PWR**	**70**	**Th/U-233 ox**	**Seed/Blanket**
1983-1989	Germany	THTR	HTR	300	Th/HEU-235	Pebble – 90% U-235

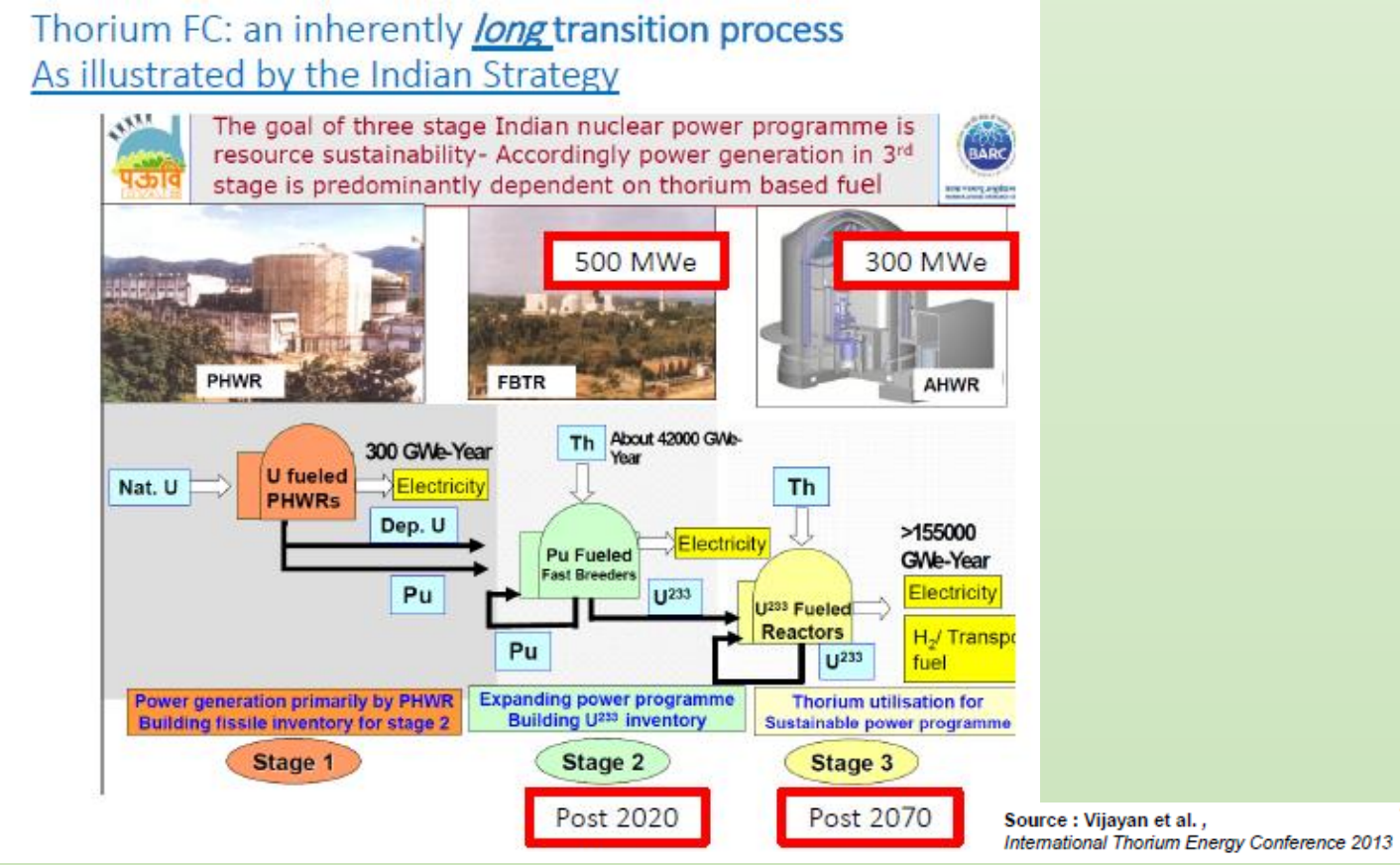




Shippingport's LWBR core

5. Thorium Fuel Cycle

An inherently long transition process, as illustrated by the Indian Strategy



Source : Vijayan et al. , *International Thorium Energy Conference 2013*

6. Resource availability of Thorium

By-product Production of thorium from other industrial mining activities can provide more than ample quantities of thorium for potential use in the nuclear industry for this century and beyond:

- Rare Earth ore mining
- Ilmenite (titanium ore) mining
- Iron ore mining