THORIUM ENERGY: INDIA AND THE WORLD

Presentation at the TEA'7 conference
Stanford Sheraton, Palo Alto, CA, June 3, 2015

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FLOWER NUCLEAR SYMBOL: THORIUM POWER

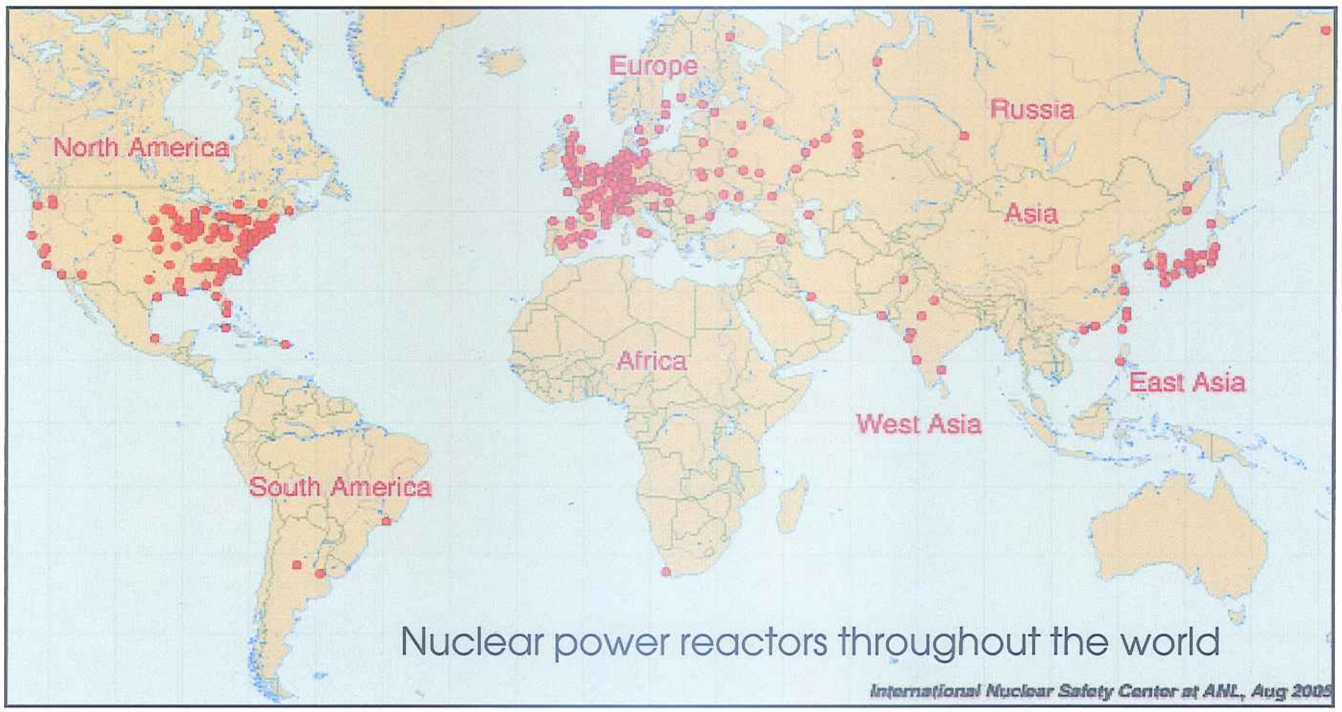
What if we could build a nuclear reactor that offered no possibility of a meltdown, generated its power inexpensively, created no weapons-grade by-products, and burnt up existing high-level waste as well as old nuclear weapon stockpiles? And what if the waste produced by such a reactor was radioactive for a mere few hundred years rather than tens of thousands? It may sound too good to be true, but such a reactor is indeed possible, and a number of teams around the world are now working to make it a reality. What makes this incredible reactor so different is its fuel source: Thorium.

Named after Thor, the warlike Norse god of thunder, Thorium could ironically prove a potent instrument of peace as well as a tool to soothe the world's changing climate. With the demand for energy on the increase around the world, and the implications of climate change beginning to strike home, governments are increasingly considering nuclear power as a possible alternative to burning fossil fuels.

(from:http://www.cosmosmagazine.com/node/348/) April 2006

FUTURE BRIGHT FOR THORIUM FUELS

- Interest in Thorium utilization is continuing in many countries, particularly India, where collaborations are being established for joint research in the deployment of Thorium nuclear fuel designs motivated by non proliferation concerns



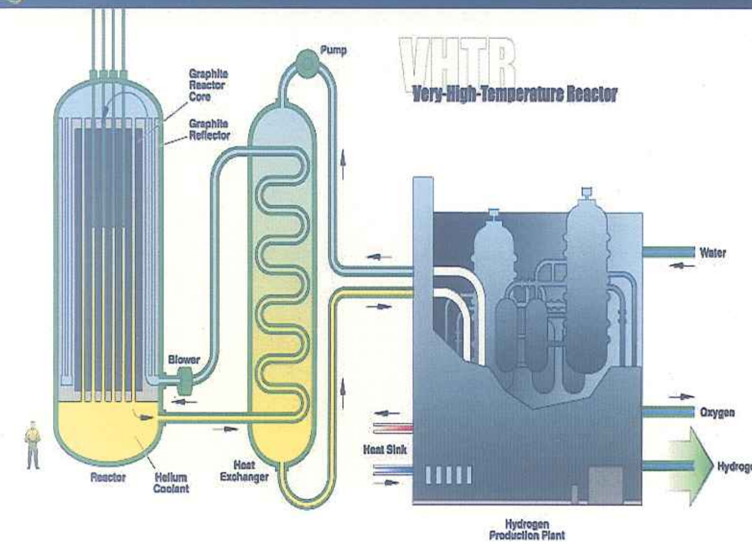
Industrial Experience of Thorium

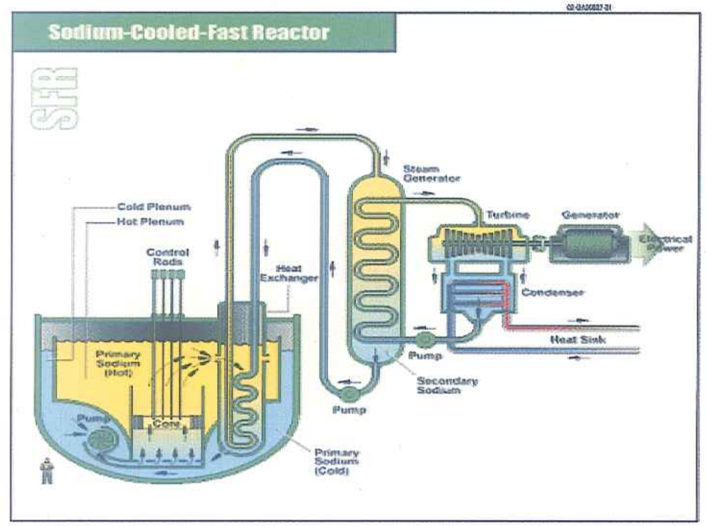
Country	Name	Type	Power	Operation	Fuel
Germany	AVR	HTGR	15 MWe	1967 – 1988	Th+U235 Driver,coated fuel particles
Germany	THTR	HTGR	300 Mwe	1985 – 1989	Th+U235 Driver,coated fuel particles
UK, OECD					
EURATOM	Dragon	HTGR	20 MWth	1966 -1973	Th+U235 Driver,coated fuel particles
USA	Peach Bottom	HTGR	40 Mwe	1967 – 1974	Th+U235 Driver,coated fuel particles
	Fort St Vrain	HTGR	330 MWe	1976 – 1989	Th+U235 Driver,coated fuel particles
USA (ORNL)	MSRE	MSBR	7.5 MWth	1964 – 1969	U233 Molten Fluorides
USA	Shippingport	LWBR PWR	100 MWe	1977- 1982	Th+U233 Driver, oxide pellets
	Indian Pt 1	LWBR PWR	285 MWe	1962-1980	Th+U233 Driver, oxide pellets
India	KAMINI	MTR	30 kWth	In operation	Al+U233 Driver,'J' Rod of Th&ThO2
	CIRUS	MTR	40 MWth	In operation	same as KAMINI
	DHRUVA	MTR	100 MWth	In operation	same as KAMINI
	KAPS 1&2	PHWR	220 MWe	Continuing in all	ThO2 pellets
	KGS 1&2	PHWR	220 MWe	new PHWRs	same as KAPS
	RAPS 2,3,&4	PHWR	220 MWe		same as KAPS
	FBTR	LMFBR	40 MWt	In operation	ThO2 blanket
Canada	NRU &NRX	MTR		Irradiation-testing	Th+U235, Test fuel

THORIUM SYMBIOSIS: Converter-Breeder Strategy (Gen IV)

NGNP NEXT GENERATION NUCLEAR PLANT

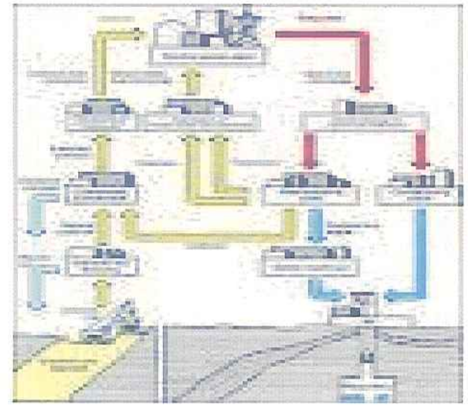
- The first stage is the deployment of LWR's on a once-through fuel cycle, which is the current Generation II reactors and U/Pu fuel cycle
- In the second stage, large numbers of advanced converters utilizing thorium are installed after the year 2020. The advanced converters initially operate on relatively efficient once-through fuel cycles. Operation at high conversion ratios is introduced as U-233 becomes available from recycle and production at high conversion ratios is introduced.
- Advanced converters, such as the NGNP VHTR being developed at INEL, become the dominant reactor type as LWRs are retired, and they remain so during the transition to a long-term symbiotic system with about three advanced converters per fast breeder reactor.
- In the third stage, U-233 is introduced into the blankets of fast breeders, such as the NGNP SFR also being developed at INEL
- (SOURCE: Larrimore, J.A., "Reactor Technology Utilizing the Thorium Fuel Cycle", GA Project 4973, September 1982.)

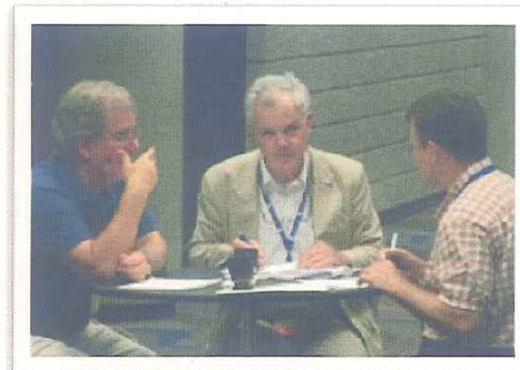




International Thorium Symbiosis

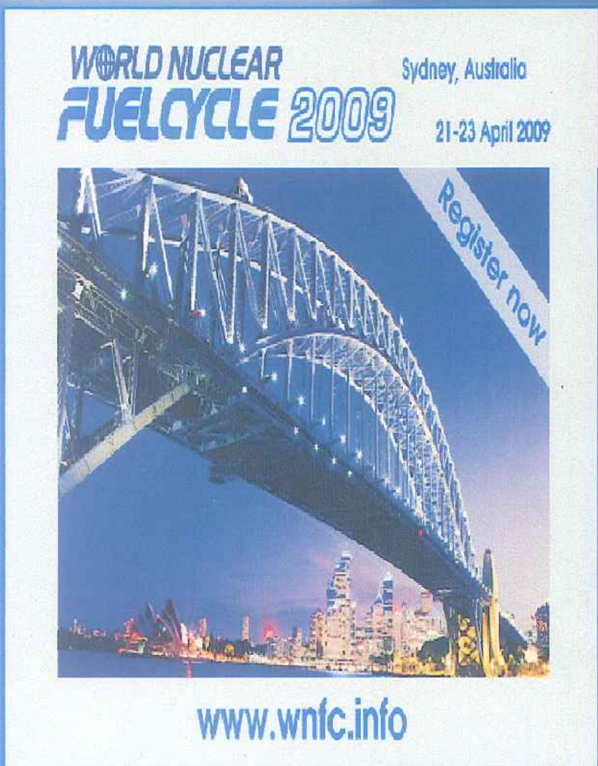
- Thorium symbiosis on an international scale is also attractive and offers economies of scale, reduced power costs, minimized environmental impact, and enhanced assurance of nuclear supply. It also facilitates controls for safeguards and nonproliferation.
- An example of a possible international nuclear cooperation arrangement based on thorium symbiosis is as follows: multinational cooperation is established between an industrialized country (or countries) with a large nuclear power program and several associated countries whose installed nuclear capacities are smaller than 30 to 50 GW(e) needed for economic scale domestic reprocessing facilities.
- The industrialized country hosts fuel cycle centers with facilities for spent fuel storage, reprocessing, conversion, and recycle fuel fabrication. SFRs are possibly collocated and associated with the centers and the electricity generated is used in the grid of the host country. Spent fuel is received from the associated countries and is reprocessed, and the fissile and fertile materials are recovered and converted. The plutonium is fabricated with uranium into core fuel elements for the associated SFRs.
- Thorium fuel from the SFR blankets is reprocessed along with thorium containing fuel from advanced converters. The recovered U-233 is refabricated with thorium into fuel elements for advanced VHTR converter reactors. The U-233 enrichment in this fuel depends on reactor usage as well as on any constraints imposed for nonproliferation concerns. Th/U-233 fuel is used in advanced VHTR converter reactors in the host country and in associated countries which have installed advanced VHTR converters in addition to their first generation LWRs or HWRs.
- As a result of this multinational cooperative arrangement, plutonium generated in thermal reactors in the associated countries is used in SFRs in the host country to produce U-233.

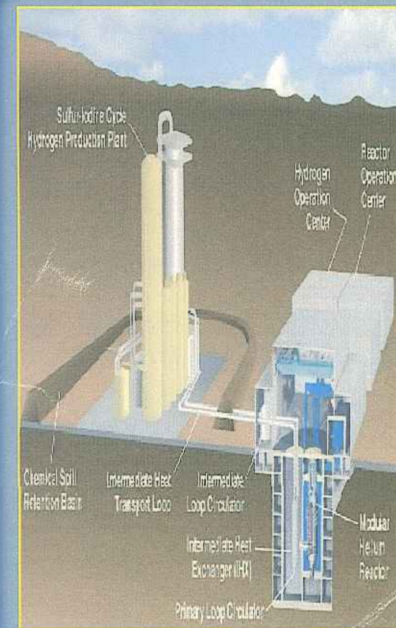




SOURCE: Larrimore, J.A., "Reactor Technology Utilizing the Thorium Fuel Cycle", GA Project 4973, September 1982.

CLOSING THE NUCLEAR FUEL CYCLE





THORIUM AND ADVANCED ALTERNATIVES

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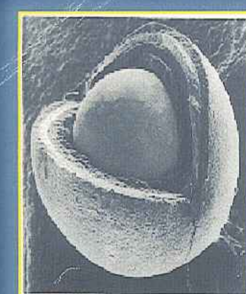
On Leave to GA, '08-'09



GENERAL ATOMICS