Reprocessing of Irradiated Thoria Bundles from Power Reactors in India

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Attractive features of Thorium Fuel Cycle are many Viz; i) uniform distribution in earth's crust with 3-4 times abundance compared to uranium leading to better resource availability ii) better chemical stability resulting in stable waste-form and thereby better stability in Geological Repository, if disposed off directly iii) reduced radiotoxicity due to lesser long lived minor actinides iv) U^{233} proliferation resistance in presence of high energy U^{232} etc. However; there are several challenges especially atthe back end of Thorium Fuel Cycle such as dissolution of irradiated ThO_2 based fuels, high gamma radiation associated with short lived daughter products etc.

In Indian context, with limited resources of uranium and abundance of thorium, a systematic work has been carried out at BARC since late sixties towards development of Thorium Fuel Cycle including reprocessing and recycling technology.

After implementing the processing of irradiated fuel from research reactors at Uranium Thorium Separation Facility (UTSF) successfully, a Power Reactor Thorium Reprocessing Facility (PRTRF) was set up at BARC, Trombay to reprocess thoria bundles irradiated in 220 MWe PHWRS. This facility has been hot commissioned in January 2015 by reprocessing a few irradiated bundles from PHWRs. Many such bundles with 19 pins /bundle and average irradiation levels of 8000 MWD/Te are to be reprocessed in this facility. Based on the reprocessing of four bundles with 7000 MWD/T, and 11 years of cooling, U^{233} recovered was 100-140 g/bundle with U^{232} nearly 165 ppm. Zircaloy clad bundles were chopped using LASER assisted single pin chopper with satisfactory performance. Dissolution of the chopped fuel was carried out using nitric acid in presence of aluminium nitrate and sodium fluoride. Sample analysis confirmed 99.5% material recovery in the dissolver solution. 5% TBP was used for the extraction of uranium. A/O ratio deployed was 1:2 along with scrub and strip solutions. Further polishing of uranium was carried out using Ion Exchange process. Product quality achieved was very good with very low thorium contamination. The U (VI) product obtained from Ion Exchange was converted to U (IV) and was precipitated & calcined for product recovery in the reconversion laboratory. Product recovery achieved was > 94% with an overall DF~ 1.0E+5.

Portable online thoron monitors and charcoal based Thoron Mitigation System (TMS) were deployed. This TMS was effectively utilised for rapid remediation of Rn^{220} from the flowing stream since the adsorbed Rn^{220} does not survive long enough to get regenerated. Thoron release through stack perbatch with regard to annual authorized release was less than 0.147%. Contact dose on the cell walls was < 1mR/hr.

Experience gained though limited, indicate that reprocessing of irradiated thoria is not as difficult as is being projected and earlier deployment of thorium is bound to dramatically improve energy sustainability specifically in the Indian context.

Mr. Piaray Kishen Wattal

Mr. P.K. Wattal has played a lead role in developing and deploying of technologies for the back end of the nuclear fuel cycle (reprocessing & waste management). His contributions in deploying innovative processes and

technologies has contributed in establishing India as one of the lead countries in the area of safe management of radioactive waste based on the philosophy of recycle and recovery.

Significant contributions of Mr. P.K. Wattal have been in deploying actinide partitioning of high level waste, first of its kind internationally, reprocessing of irradiated thoria from power reactors, value recovery of Cesium and its deployment for irradiation purposes as a societal application.

Mr. Wattal has taken special initiative in addressing all types and categories of legacy alpha bearing wastes in India by deploying novel processes and technologies which continues to be an international concern. This endeavor will go a long way in sustainability of Indian nuclear power programme. Mr. Wattal was a Member of Technical Working Group on Nuclear Fuel Cycle Options and Spent Fuel Management (TWGNFCO) of IAEA, Vienna. He also led Indo-French Programme on Rad-waste Management. He has several publications to his credit in National and International Journals. Mr. Wattal is a Fellow of Indian National Academy of Engineers (INAE).