

On the use of high-assay low-enriched uranium–thorium fuel cycles in pressurised heavy water reactors

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High-assay low-enriched uranium (HALEU) fuel has a ^{235}U enrichment range of 5% to 20%. The Indian 220 MWe pressurised heavy water reactor (PHWR-220) uses natural uranium (0.7% ^{235}U and 99.3% ^{238}U) as fuel. The energy extracted per unit mass of fuel or burn-up in these PHWRs is ~ 7 GWd/t. In the case of pressurised water reactors (PWRs), which use close to 5% enriched ^{235}U fuel, the burn-up is ~ 50 GWd/t. Therefore, the irradiated spent fuel discharged from PHWRs is ~ 7 times more than that of PWRs. To reduce the annual spent fuel generation, a HALEU-Th based fuel is being suggested, where HALEU is mixed with Thorium to make a mixed oxide fuel with an average fissile ^{235}U content in the range of 3-4% and with a target discharge burn-up of ~ 50 GWd/t, similar to the one attained in standard PWRs. The present article explores the features of the HALEU-Th fuel cycle in 220 MWe PHWRs, based on core-level analysis, to determine the benefits and challenges of transitioning from the NU fuel cycle to HALEU-Th. In addition, the use of slightly enriched uranium (SEU, with $\sim 1.1\%$ of ^{235}U in U) in PHWRs has also been studied for comparison.

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