Ultra-long Fuel Cycle Design for Advanced LWRs
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Funding: EPSRC Nuclear CDT
Available: October 2014

Advanced fuel cladding materials for Light Water Reactors (LWRs) are being actively studied for the purpose of increasing the fuel endurance under accident conditions. These materials include for example SiC composites and advanced stainless steels, which, unlike conventional Zr based alloys, exhibit much slower oxidation kinetics and retain strength at high temperatures. In addition to improving accident tolerance, these advanced cladding materials can potentially allow the fuel to achieve much longer in-core residence time and allow operation at higher power. Such long fuel cycles offer clear economic incentives by improving availability of the reactor and reducing the volume of waste generated per unit energy produced.

Longer fuel cycles however would require an increase in the initial fuel enrichment which may be beyond the licensing limit of the existing fuel enrichment, fabrication and handling infrastructure. The use of mixed oxide UO2-PuO2 (MOX) fuel could be a potential alternative. However, the initial Pu loading is also limited by the core reactivity feedbacks which may become positive at high Pu concentration. Thorium based MOX (ThO2-PuO2) on the other hand, does not have any of those limitations. Furthermore, high burnup would allow maximizing the energy share contributed by fissile U233 bred from Th and therefore make very efficient use of the initial fissile Pu maximizing its value.

This project will investigate practical limits for alternative fissile-fertile fuel combinations for achieving substantially longer than currently practiced fuel cycles.