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THORIUM AND TRANSURANIC ADVANCED FUEL CYCLE – AN OPTION TO BRAZILIAN NUCLEAR PLANTS

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A typical PWR fuel element considering (TRU-Th) cycle was simulated. The study analyzed the behaviour of the thorium insertion spiked with reprocessed fuel considering different enrichments that varied from 5.5% to 7.0%. The reprocessed fuels were obtained using the ORIGEN 2.1 code from a burned PWR standard fuel (33,000 MWd/tHM burned), with 3.1% of initial enrichment, which was remained in the cooling pool for five years. The keff, hardening spectrum, and the fuel evolution during the burnup were evaluated. This study was performed using the SCALE 6.0.

1. Introduction:

A study of thorium reprocessed fuel insertion in a PWR fuel element was analysed, considering different enrichments that varied from 5.5% to 7.0%.

2. Methodology:

The reprocessed fuels were obtained using the ORIGEN 2.1 code from a burned PWR standard fuel (33,000 MWd/tHM burned), with 3.1% of initial enrichment, which was remained in the cooling pool for five years. The burned fuel was submitted to a UREX+ reprocessing technique which recovers 99.95% of uranium, 71.0% of neptunium, 99.5% of plutonium, 98.0% of americium and 79.0% of curium. The recovered elements were spiked with ^{232}Th until obtaining the desired fissile quantity. A (TRU-Th) fuel element with different enrichments was evaluated and compared with a typical UO_2 (3.2%) using SCALE.6.0, through KENO-VI and TRITON control modules.

The fuel element is shown in Fig. 1

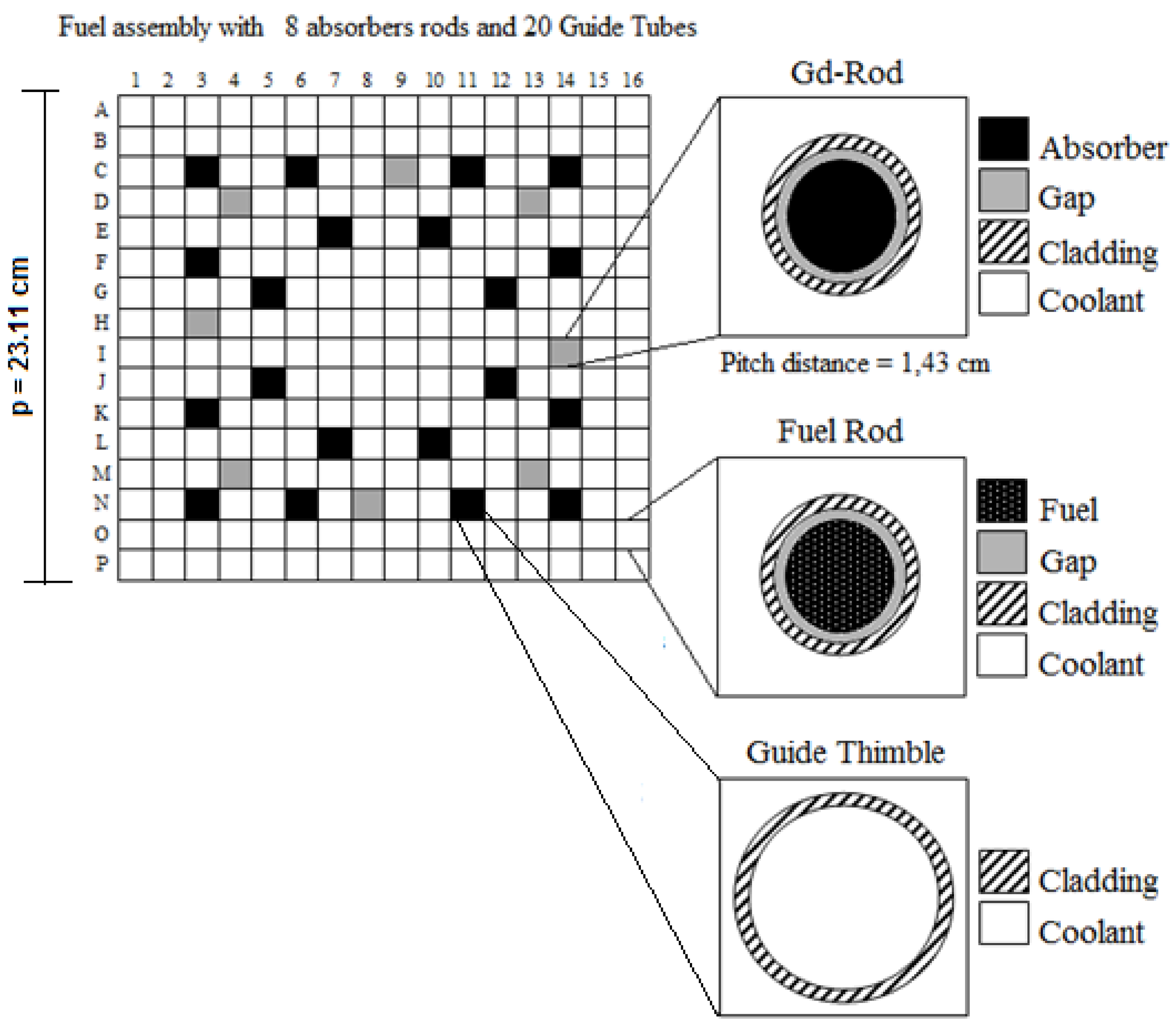

Figure 1 - The fuel element

3. Results:

The keff values are shown in Fig. 2. Considering all fuels, the initial keff value is lower for (TRU-Th) than for (UO_2) fuel. Comparing to UO_2 standard fuel with the greater fissile material quantity (TRU-Th), the behaviour is more similar at the begging of life but at the end, the keff of (TRU-Th) indicates the possibility of an extended burnup. Nevertheless, another neutronic and thermal-hydraulics parameters must be analysed to guarantee this possibility.

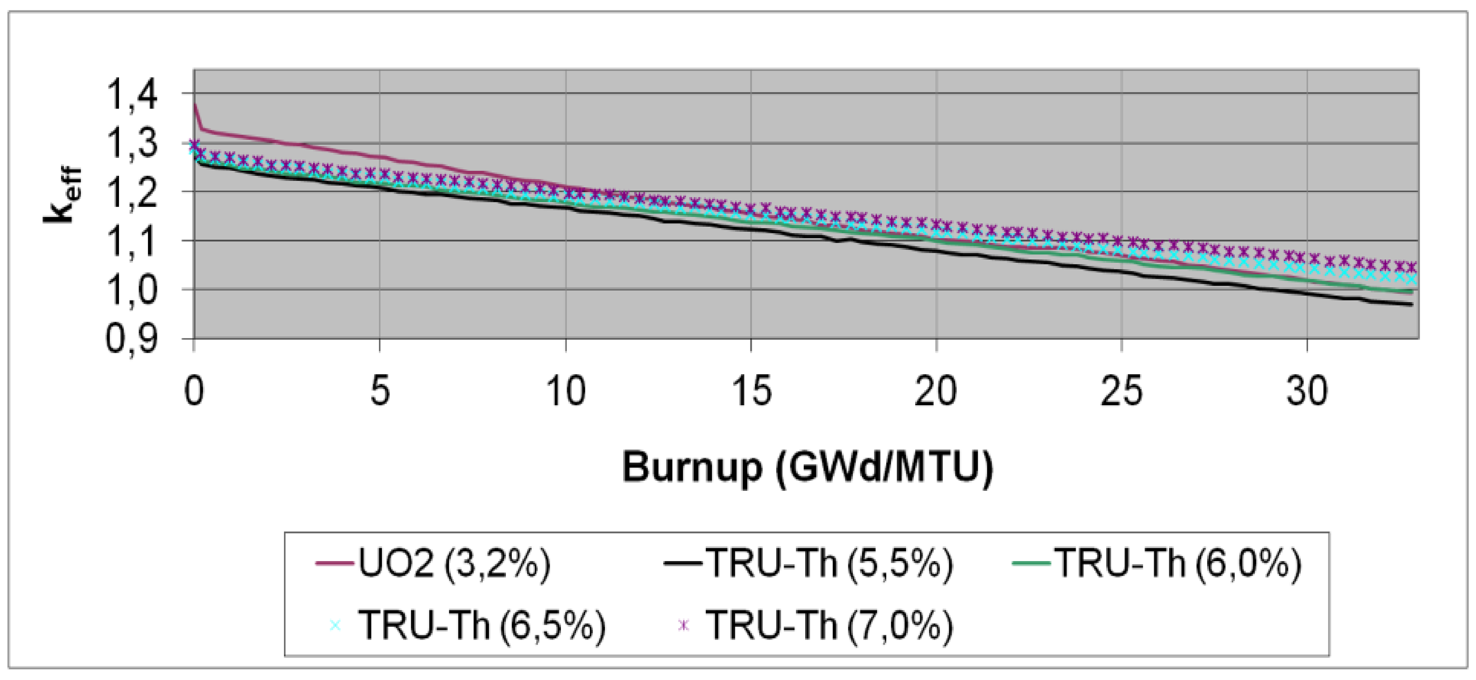

Figure 2 - keff during the burnup

Figure 3 presents the hardening spectrum for each analyzed fuel, considering the different enrichments for the reprocessed fuels. The spectrum of fuel with TRU is more hardening due to their high thermal neutron absorption cross sections.

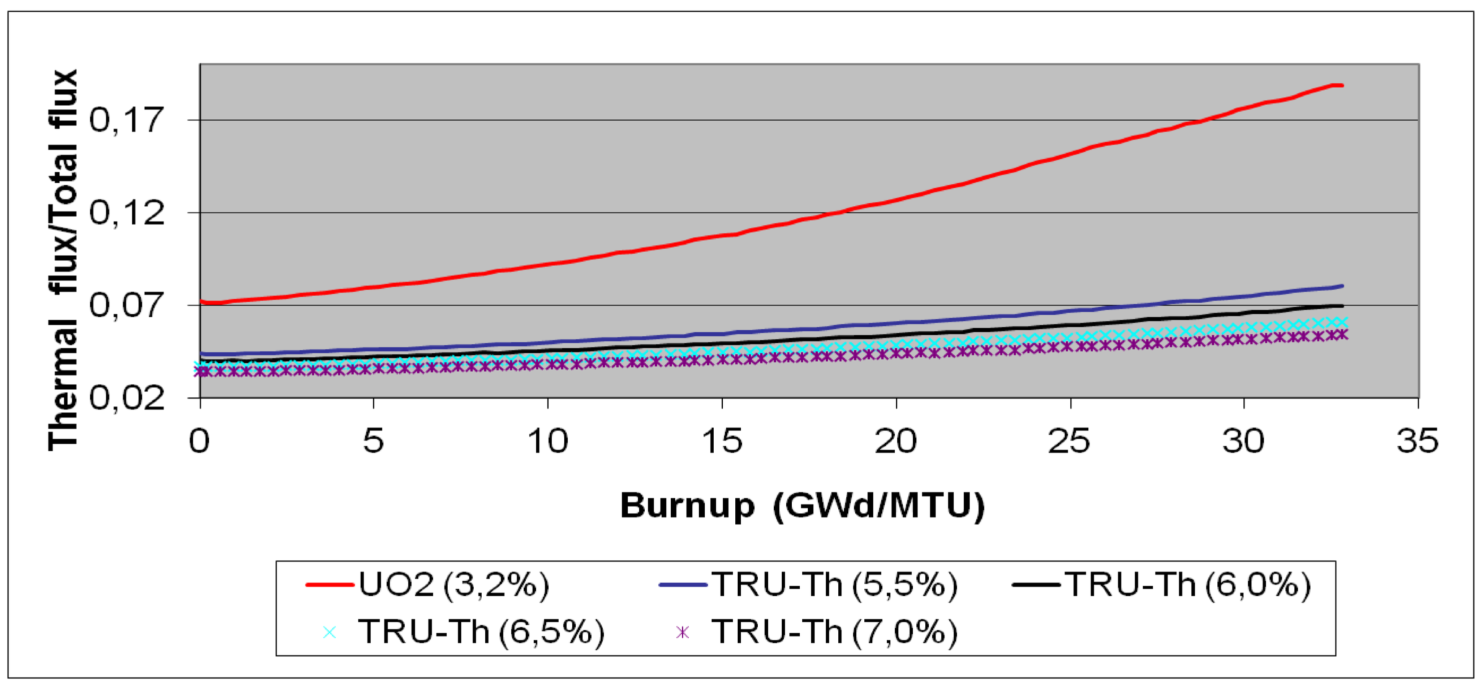

Figure 3 – The hardening spectrum during the burnup

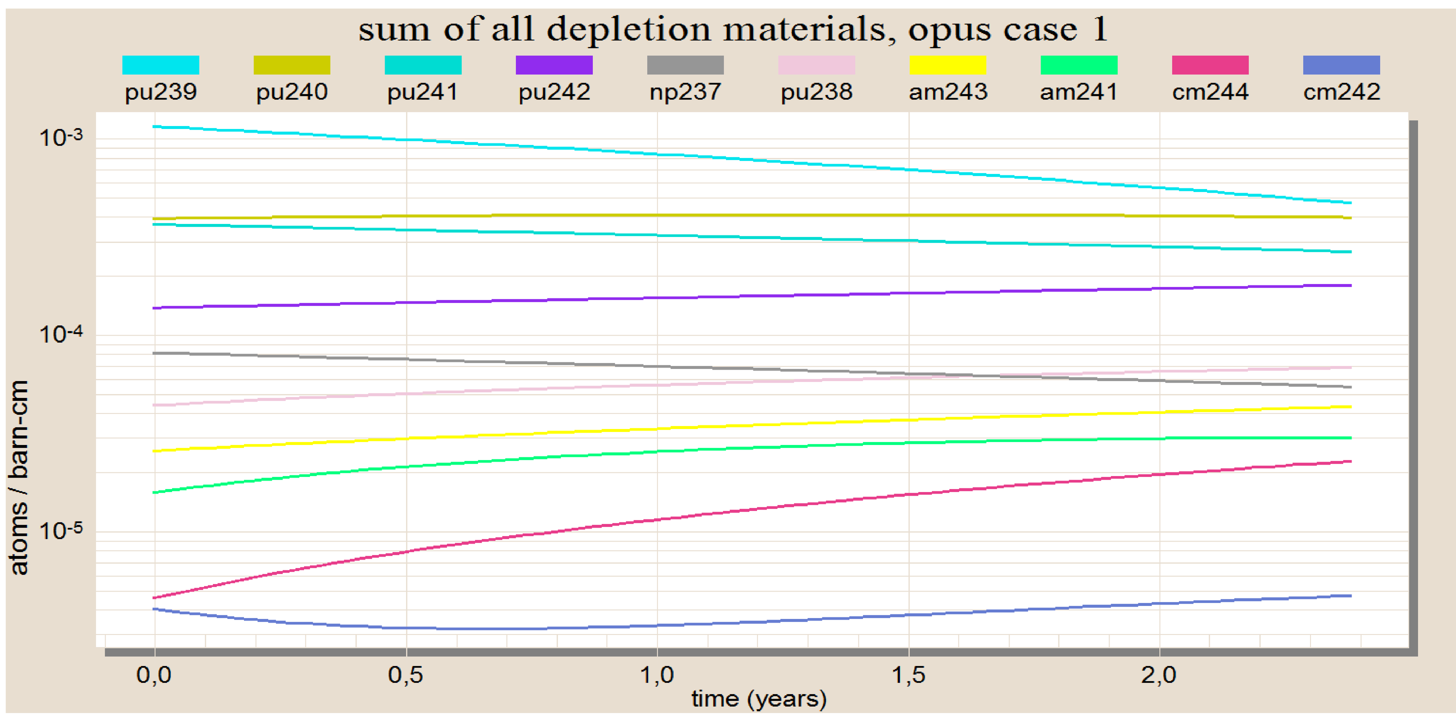

Figure 4 - TRU-Th (7,0%) evolution during burnup

4. Conclusions:

In a first analyzes, the utilization of advanced fuel based on thorium with transuranic elements in a fuel element of a typical PWR indicates a possibility of an extended burnup. The good results allow extending the study to evaluate a core and another neutronic parameters will be analyzed to verify the possibility of using (TRU-Th) fuels in PWR.

Acknowledgments