Computational simulation of fuel burnup estimation for research reactors plate type

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The aim of this study is to estimate the spatial fuel burnup by computational simulation, for two research reactors plate type, dispersion, with different dimensions: the benchmark Material Test Research – International Atomic Energy Agency (MTR–IAEA) and a typical Multipurpose Reactor (MR). To develop this work was used the deterministic code, WIMSD-5B and the DF3DQ code, based on neutron diffusion theory, written in FORTRAN.
The first step it was the construction of the equivalent cell and the calculation of the thicknesses and atomic concentrations to each region of that cell, these information was used as entrance data for WIMSD-5B, allowing that to supply the parameters homogenized nuclear associates every day of it burnup stipulated. The spatial fuel burnup was supplied by DF3DQ code. For the numerical solution of the diffusion equation was used Finite Difference Method with the outer and inner iteration scheme using Gauss-Seidel method, with the multiplication factor being determined by the power method. The DF3DQ calculates the spatial burnup and then a subroutine nuclear interpolates the generated parameters in this step with those provided by WIMSD5 B. The new nuclear parameters resulting from the interpolation feed back to the neutron diffusion equation, and calculations are repeated according to the steps of pre-determined burnup, until finishing the program [1]
The WIMSD-5B and DF3DQ codes were employed in spatial fuel burnup simulations for two cases: MTR - IAEA and MR.
The Figure 1 shows the radial geometry of the reactor core MTR-IAEA. The Figure 2 shows the simulations results of the accumulated burnup the 1st and 31st day for the MTR-IAEA. The unit used for burnup was the MWd/t. The Figure 3 shows a cross-section (*xy* plane) of the MR. The Figure 4 shows the variation of accumulated burnup in 21 days for the MR.

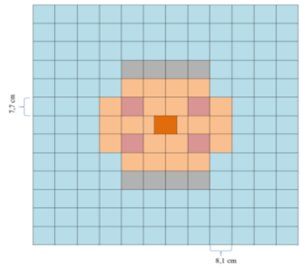

Figure 1. Reactor core - MTR - IAEA

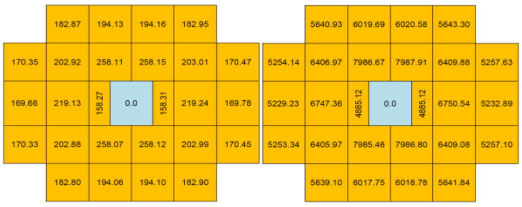

Figure 2. Accumulated burnup (MWd/t) per Fuel Element - 1º and 31º day

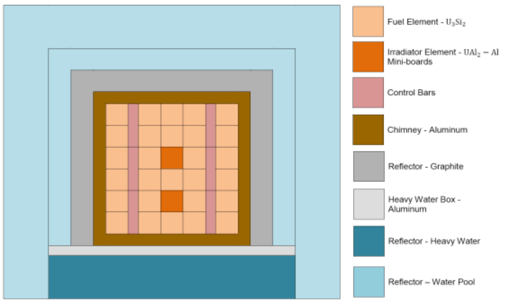

Figure 3. *xy* plane of the MR

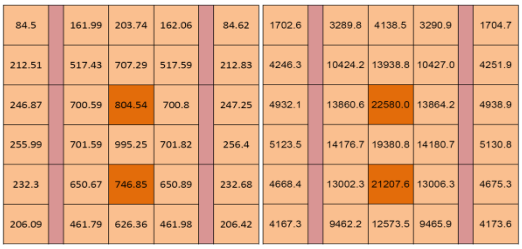

Figure 4. Accumulated burnup (MWd/t) per Fuel Element - 1º and 21º day.

The results obtained by the simulations were as satisfactory. It was concluded that the methodology and the tools WIMSD-5B and DF3DQ used to estimate the spatial fuel burnup, can be applied the other research reactors.

Reference

[1] SANTOS, N. R. **Estimativa da Queima Espacial do Combustível para Reatores Nucleares de Pesquisa**. 2014, 91 f. Dissertação (Mestrado em Ciência e Tecnologia Nucleares)-Instituto de Engenharia Nuclear da Comissão Nacional de Energia Nuclear, Rio de Janeiro, 2014.