Fuel assessment for Argonauta using MCNPX

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By looking at a growing demand for services using the techniques developed in the Argonauta reactor, mostly driven by the construction of the Brazilian Multipurpose Reactor (RMB) and expansion of R & D activities, an increment in the neutron flux by an order of magnitude of 10E1 would not only be important but fundamental to the new reactor's applications. In this regard, replacing the current fuel with a new one based on more modern technologies and materials will bring greater reliability to the new operation. One of them refers to the application of the non-destructive test technique (known as neutronography, neutron radiography), which has application in the quality control of supplies for the aerospace industry. Another application is the production of radioisotopes used as radiotracer in several industrial areas, especially in the oil industry.
The new fuel load integrates a series of actions foreseen in the project "Modernization and Adequacy of the Facilities of the Argonauta Reactor - IEN and Associated Laboratories". This report is aiming to assess a variety of fuel options and indicate the one that better suits future operation requirements. For that it was tested different densities and assemblies, including number of plates per fuel and spacing between them. A series of cases were simulated with MCNPX v2.7 code and results are shown below.

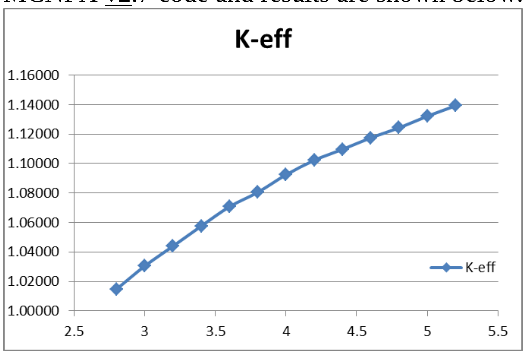

Figure 1. Effective neutron multiplication factor variation according to uranium density change.

First test was the density variation. Uranium silica fuel (U2Si3) can be manufactured in densities ranging from 2.8 to 5.2 grams of uranium per cubic centimeter (2.8 - 5.2 gU / cm3). Aiming to analyze the influence of density on reactivity, a reactor with 6 fuel elements of 17 plates was considered. A simulation was performed for each case, and a step of 0.2 g / cm3 was adopted, resulting in a total of 13 cases. For each case, 500 cycles each containing 500,000 particles were performed. Second test consisted in varying the number of plates in the last fuel element and evaluate the impact in the reactivity due to additional plates. Results are shown below:

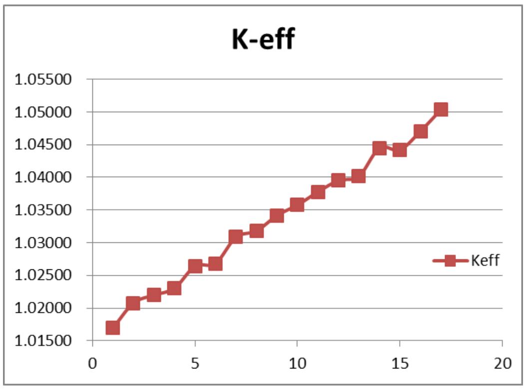

Figure 2. Reactivity increase due to addition of fuel plates.

It is noted that the increase in density does not have such a significant effect at higher values, suggesting saturation. Therefore the gain of reactivity with respect to the increase in uranium mass is not proportional, showing that it would be a not so effective way of increasing reactivity efficiently. The addition of plates in the last element has an approximately linear behavior with respect to reactivity, suggesting that the variation of the number of intra-element plates in this case is not going to have any secondary impact and that therefore other factors, such as example, the flow distribution, should be taken into consideration at the time of defining this number.

References

[1] X-5 MONTE CARLO TEAM. MCNP. A General Monte Carlo N-Particle Transport Code. Version 5. v. 1/2/3, Los Alamos: LANL, 2003.
[2] LEWIS, E. E. **Fundamentals of nuclear reactor physics**. 1. ed. Amsterdam: Academic Press, 2008. 280 p.